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ERRORS OF GUN-FIRE AT SEA.

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That the gun will always be the decisive weapon in naval combat seems to me the most natural conclusion to be derived from theoretical considerations, and such practical experiences as recent wars have furnished would tend to the same conclusion. Gun-fire and gun-fire alone decided every naval action which took place in the war between China and Japan and in our own war with Spain, and whatever other conclusion may be drawn from those wars, they should certainly have taught us the overwhelming advantage given by a superior volume of effective gun-fire. How to make the volume of effective gun-fire of any given ship a maximum should, then, be considered the most important end which her officers can possibly have in view, and, since marksmanship is the prime factor in effective gun-fire, a study of the errors of gun-fire at sea and the methods of minimizing them should be of great value. Those who are without practical experience naturally fail to appreciate the difficulty of hitting a target with a gun on board ship, but even naval officers, I think, usually underestimate the errors of gun-fire at sea, and especially

so at the great ranges which are likely to be used in naval actions. The ever increasing effectiveness of offensive weapons, with which the development of the defense in itself never keeps pace, is well known. That the rapidity of fire, as well as the muzzle velocity with its accompanying flatness of trajectory, of modern guns, whether shoulder rifles or heavy ordnance, are much greater to-day than they ever were before, is a matter of common knowledge, and the natural consequence which would seem to follow is a greatly increased destructive effect. That the real result has been the opposite of this, at least in land fighting; that increased efficiency of offensive weapons has continually resulted in less loss of life in battle, few have observed. Yet this is true, and the reason is not far to seek. It is because, all other defenses having proved inadequate, the defense of distance has been more and more made use of. In the days when it could be truly said that beyond 150 yards no man was in danger from a shot which was aimed at him, it was necessary to any conclusion that battles should be fought almost, if not quite, hand to hand. To-day, when, if the distance be known, a good target can be made with the small arm at 1800 yards and when, up to 700 yards, the shooting is point blank, a great battle may be decided without there being a single opportunity for either side to fire an aimed shot at an individual opponent. In like manner, upon the sea, there has been a constant tendency to seek the defense of greater and greater distances in proportion as the offensive power of naval ordnance has increased. The surprising reports of "no casualties," when Dewey's ships withdrew for a time from the action at Manila Bay, may be in part attributed to the complete inefficiency of the Spanish navy, and its shameful neglect of gun practice, but it must not be forgotten that the action opened at nearly 6000 yards, and that the Spanish had for a target moving vessels which were never nearer than 2000 yards, and whose mean distance, during the first and really decisive engagement, must have been nearly two miles. Our much greater volume of fire, and the comparative immobility of the Spanish ships, resulted in an easy victory, but the percentage of hits from our own guns, though greater than the enemy's, was nevertheless very small. .I have been told by an officer of the Raleigh that, during one phase of the action, he distinctly saw that the shots from the Baltimore and Olympia were falling at least 500 yards short of the enemy.

I take a range of 2000 yards as a basis for a discussion of the errors of gun-fire, but the principle of the "rigidity of the trajectory" indicates that most of the errors are proportional to the range, and that the total errors at 3000 yards, for example, will be about fifty per cent greater than at 2000 yards range.

If the points of impact of a great number of shot are plotted on a vertical target at whose center the gun is pointed, what is called the "mean vertical error" is the arithmetical mean of the distances, either above or below the center of the target, of all the points of impact; and the "mean lateral error" is similarly the mean of the sidewise errors.

The "probable error" or the error such that half the shot have a less, and half a greater error, is a little less than the mean error just defined, so that while 50 per cent of all the shot fired would be found within a band double the width of the "probable error," 57½ per cent would be found within a band twice as wide as the "mean error."

"Tables of probability," found in many books on ordnance, give the percentage of hits for bands of given width in terms of the mean error, and by knowing both the mean vertical and the mean lateral error of a gun, we easily find the percentage of hits within any given lateral limits, the percentage within any given vertical limits, and then, by multiplying these percentages together, the percentage of hits on any given rectangular area. The first step, then, in determining the probable percentage of hits with any given gun is to determine the mean vertical and lateral errors of the latter, and this I shall now try to do in a rough, but I think sufficiently accurate manner, by considering the separate causes of error, and the effect of each separately, and then combining them; and furthermore, I shall make no attempt to discriminate between the different calibers, but shall assume all so-called "main battery" guns to have practically the same mean error, which, while not exactly true, is still, for the purposes of my general review of the subject, sufficiently accurate.

Now the mean error of the gun itself does not exceed 2 feet laterally and 5 feet vertically at 2000 yards, that is, if the range be known, the line of sight be truly on when the projectile leaves the muzzle, and there be no wind, the impact will, on the average, be within 2 feet laterally and 5 feet vertically of the center,

the excess of vertical over lateral mean errors being due to variations in muzzle velocity from round to round. The great precision of the modern heavy gun may be judged from the target record which I have here of a 10-inch army gun at 2000 yards range, which shows mean errors, both vertical and horizontal, of less than 1 foot. The high velocities, with accompanying great variations in velocity, given by smokeless powder, have probably tended to increase the mean error of the gun somewhat, but my assumed figures of 2 feet lateral and 5 feet vertical mean error at 2000 yards are certainly not an underestimate.

Taking next the errors due to rolling and pitching, and assuming that electric firing is used so as to reduce to a minimum the firing interval, I estimate the vertical and lateral mean errors at 2000 yards range from this cause to be each about 3 feet, the first of these errors being due to angular movement between the moment of firing and the departure of the projectile from the muzzle, and the second being due to inclination of the axis of the trunnions at the moment of firing. Next considering error due to wind: this is practically lateral only, and supposing it due to a 10-knot breeze at right angles to the line of fire, would be about 3 feet. The error caused by the relative movements of gun and target is also practically only lateral, and, if due to a mistake of 4 knots in the lateral motion allowed for in sighting, would be about 20 feet at 2000 yards. Finally, we have to consider the fact that the range is only approximately known, and that, consequently, there is always an error in setting the sights. Supposing this to average 100 yards, and the result is a mean vertical error at the target of about 7 feet with our present service guns, and, of course, it will be less when muzzle velocities are increased. Now taking the square root of the sum of the squares of all the foregoing errors, we have for the total mean lateral error 20½ feet, and for the total mean vertical error 9 feet.

Let us see how nearly the results of firing agree with these figures. It was the actual count of the hits on the Spanish ships at Santiago which first gave us a measure of our own efficiency as marksmen. The rapid and complete destruction of the Spanish squadron seemed to justify the enthusiastic praises then being showered upon our "Yankee gunners." But when the hits came to be actually counted, the astonishing result was that of some 9500 projectiles fired, only 123, or 1.3 per cent, had found their mark on the Spanish ships. Considering the guns as

divided into three classes, I find that, from the heavy guns, 8-inch, 12-inch and 13-inch, 405 shots were fired with 16 hits, or nearly 4 per cent; from the medium guns, 4-inch, 5-inch and 6-inch, 895 shots were fired with 30 hits, or 3.4 per cent; while from the 6-pounder guns, 6580 shots were fired with 77 hits, or 1.2 per cent. I omit consideration of nearly 1600 shots fired from smaller guns, and count all their hits as 6-pounders, as it is impossible to certainly distinguish a one or a three-pounder hit from a six-pounder. Furthermore, assuming that all the 8-inch, 12-inch and 13-inch shell and most of the 4-inch, 5-inch and 6-inch were fired at the Spanish ships, while many of the minor caliber shots were fired at the torpedo-boats, and also allowing for the fact that there were probably some hits on the Spanish ships which escaped observation, I conclude that, while the percentage of hits was somewhat less for the minor caliber guns than for the larger guns, for all calibers of the latter, from 4-inch to 13-inch, it was practically the same, and in the neighborhood of 4 per cent, certainly not as great as 5 per cent, and probably very slightly greater than 4 per cent. Let us see what we must conclude from these percentages of hits as regards the errors of the guns. A consideration of the positions of the ships as laid down by the board of navigators indicates a mean range, during the decisive part of the action, of about 2800 yards. To get this, I take the average of the distances of each of our ships from her nearest opponent during that part of the action in which such distances were not too great for a reasonable chance of hitting, and then, by assigning a greater weight to the nearer distances than the farther ones, I make a new average, which I consider the mean range for the entire battle.

Next I assume as the mean size of target offered by each Spanish ship, a rectangle 200 feet long and 24 feet high, which, considering their position relatively to our line of fire, cannot be far out.

Finally, with the foregoing data and on the assumption that the mean lateral and vertical errors were equal, it is easy to pick out from any table of probabilities the mean error of our guns as having been about 100 feet. It is astonishing, but nevertheless I think it is beyond doubt, that at a range of 2800 yards the mean error of the guns at Santiago, if measured on a vertical target, would have been found to be about 100 feet, that is, nearly half our shot went more than 100 feet to one side or the other of

the center of the ship aimed at, and nearly half went more than 100 feet above or below the same point.

But my theoretical mean errors of 9 and 20½ feet respectively at 2000 yards are only about one-fifth of those just found to have actually been made at Santiago—the percentage of hits, according to my figures of the guns' accuracy, should have been 57 instead of 4. In what, then, lies the explanation of this discrepancy, and why, if my figures in regard to the accuracy of the gun are anywhere near correct, do we not almost always hit the target? The answer is very simple. Thus far I have assumed that the line of sight is on the center of the target when the gun is fired. Actually this is never the case, and upon how great this "error of pointing" is, really depends almost entirely the accuracy of gun-fire. To account for the results at Santiago, we have to suppose that the mean error of pointing our guns was nearly a degree. What then causes this greatest of all the errors of naval gun-fire. It has two causes: one depending on the individual gun-pointer and only to be reduced by skilful allowance on his part; the other mechanical and capable of almost entire elimination.

The first cause is what is known as the "personal error" of the gun-pointer—the time between his willing to fire the gun and his actually firing it. If he wills to press the button when the line of sight is on the target, the motion of the ship has displaced the gun before he can really do so. With electric firing only about 1-50 of a second elapses between the actual pressing of the firing key of a 12-inch gun and the departure of the shell from the muzzle, and I have already made an allowance of 3 feet vertical error for the ship's roll during this interval. But it takes about 3-10* of a second for a man to translate the desire to fire

* This estimate is based upon tests made at the Torpedo Station by Lieut. Comdr. F. F. Fletcher. It is very large as compared with what is called the "personal equation" as determined for astronomical observers, but that is because the latter almost invariably, either voluntarily or involuntarily, attempt to correct their own errors, as is shown by the fact that some observers have negative personal equations. If a man be told to press a key when a signal is made, and if the nature of the signal is such that he has no means of ascertaining or estimating when it will come, then, according to Mr. Fletcher's experiments, an average period of 3/10 of a second will elapse between the giving of the signal and the actual pressing of the key.

into the actual motion of his hand, and the vertical error due to roll during this "willing interval" may be very great. Of course this error disappears if the sea is perfectly smooth, or if the gun is fixed at the end of a roll, but the first case is rare, and the second can only be approximated to. It is certainly important to reduce this error by pointing so that the line of sight comes on near the end of the roll, but as a rule the gun-pointer will have to make up his mind to fire just before the line of sight comes on in order to have it really on when the gun goes off, and I fear that the mean vertical error, at 2000 yards range, due to this part of the error of pointing, cannot be less than about 21 feet. This is on the assumption that on the average the gun-pointers can correct the error to within one-third of its uncorrected value, and that the ship has an average rate of roll of 2° a second during the 1-10 of a second which is not allowed for.

The second cause of the error of pointing is the inability of the human eye to see distinctly at the same moment objects at greatly different distances. When the gun-pointer attempts to bring into line the rear sight, the front sight, and the target, he glances along the line of sight from one to the other, but if he sees one of these three objects distinctly, the others are necessarily blurred. Consequently he cannot say with any exactness when the three are in one line, that is, when the line of sight is really on, and when he fires the gun, thinking they are in line, they really never are, except by pure accident. It is doubtless true that by dint of much practice this part of the error of pointing can be reduced, and with some men, who have the natural gift, it becomes very small, but no man can entirely overcome it, and very few men, no matter how long and how well they are taught, can make it even small. If, however, a telescope is substituted for the ordinary gun-sight, the difficulty of telling when the line of sight is truly on at once disappears. Instead of having three objects at different distances from the eye to bring into line, the gun-pointer has but two objects before him, the target and the cross wires of the telescope, and these are in the same plane, so that he requires no practice, nor any natural aptitude to tell when the line of sight is on. In fact, unless he be blind, he cannot help knowing when it is on.

With the ordinary sights no man can possibly say when the line of sight is exactly on, and I have no doubt but that there

is a mean error of pointing of nearly one-quarter of a degree, due entirely to this cause. With the telescope sight, this error of pointing is almost entirely eliminated, and only exists at all on account of certain practical needs.

To get, with a short telescope, the 17 degree field of view which our present telescope sights give, and also to get enough light to give a clear view under disadvantageous circumstances, we have to use an object glass of great curvature, and such a lens introduces a slight error on account of imperfect focusing of the rays of light transmitted through it. This error may be observed by looking through the telescope at a distant object, when a slight motion of the eye will seem to shift the cross wires with reference to the image of the object. It is, however, only a small fraction of the error always existing when ordinary sights are used.

Nevertheless there is much opposition to the use of telescope sights in the Navy, and a discussion of the reasons for objecting to them seems in order. In the first place I am convinced, as I have already stated, that few officers fully appreciate the errors of actual gun-practice at sea at long range. This is due to the usual absence of anything near the target, by a comparison with which they can be estimated. When it is considered that the cross wire of the T-square used in measuring the lateral distance of the point of fall from the target covers a space of 10 feet as seen at 2000 yards, it will be readily understood that the actual errors cannot be closely determined, and as a matter of fact, I have no doubt that many shot which appear from the ship to have almost struck the target would, if their points of fall had been accurately fixed, prove to have passed at such a distance as would have insured their missing a battleship placed where the target was. In the next place, the mere statement that accurate pointing is impossible with the ordinary sights and easy with the telescope carries little or no weight with most people. They neither realize the errors of the first method nor believe the accuracy of the second. As a matter of fact, however, the actual errors determined by the aiming drills on the gunnery training-ship Lancaster were reduced two-thirds by the use of the telescope, and when it came to the prize firing, and the choice was offered of using either kind of sight, all but one of the entire class of seamen gunners chose the telescope sight, the one

selecting the bar sight asking permission to change to the telescope before he had completed his score. The remaining objections to the telescope sight are entirely mechanical and can be overcome if the importance of doing so be once realized. With brown powder the glass is quickly coated with residue and can only be kept clear by constant wiping. With smokeless powders, this trouble should be much diminished but will still remain to a certain extent. Let it be remembered, however, that one shell which hits is worth more than any number which miss. Even should keeping the telescope glasses clean reduce the rate of gun-fire to half what would be obtained by the use of bar sights, there would be a clear gain in efficiency. More hits would be made in a given time by the slower than by the faster fire. Again, the present telescope mountings are of too light construction and cannot be relied upon to remain in proper adjustment. A single fire from one of the turret guns sometimes completely disarranges the telescope sight, and there is present to the gun-pointer the constant and often justified suspicion that his sights cannot be relied upon. Of course, such a condition is a fatal bar to efficient gun-practice, and should not be permitted to continue. Certainly no one will doubt but that perfectly reliable mountings can be, and if demanded will be devised and put in place of those now used. For my own part, I think it would pay to spend a million dollars, if necessary, to replace all our present telescope sights by others with improved mountings.

It has been objected to the telescope sight, especially for the rapid-firing guns, that it reduces the rate of fire by preventing the gun-captain from keeping the target in view. The fact that the present telescopes have a field of 17 degrees should sufficiently answer this objection. At 2000 yards range the space taken in by the telescope is a circle nearly a mile in diameter. The real difficulty is that with the telescope for the first time the gun-pointer perceives his errors and realizes the difficulty of actually bringing the line of sight on to the target. The rough adjustments which with the ordinary sights seemed sufficient to give him a good aim no longer suffice, and the consequent slower pointing is reproached to the telescope when it should really be recognized as a proof of its efficiency.

Under these circumstances, I cannot but feel sure that in

course of time the prejudice against the telescope sight for naval guns will disappear. Its present mechanical features of weakness will be removed, and it will replace all other forms of sights. When this happens, even allowing an error of pointing of 5 feet due to imperfections in the telescopes, and supposing the error of pointing due to roll to be corrected to one-third, the mean errors of our heavy guns at 2000 yards range will be about 24 feet vertical and 22 feet lateral—much greater than the estimates of 9 feet and 20½ feet, which I made before taking account of the "error of pointing," but very much less than as actually determined at Santiago.

The recent English experiment with the Belleisle affords a rough means of checking some of the foregoing estimates. The Belleisle was moored head and stern, and the Majestic steamed at 6 knots on a line parallel to the Belleisle's keel, starting from a point on her quarter and 1700 yards distant, being 1300 yards distant when abeam, and completing 9 minutes' firing when about 2 points forward abeam. It was intended to steam at 7 knots, which would have brought the Majestic on the Belleisle's bow at the end of nine minutes, but on account of the lower speed, the firing ceased before the full course from quarter to bow had been traversed. The Belleisle's length is 245 feet; her armored casemate or battery is about 60 feet long, and as she was 2 feet light, the target may roughly be said to have been a central part 80 feet long by 24 feet high with the ends 60 or 70 feet long and perhaps 16 feet high. The Majestic fired 15 12-inch; about 200 6-inch; 400 12-pounder, and some 750 3-pounder shell, the respective rates of fire per gun being a 12-inch round every 2.4 min., a 6-inch every 17 seconds, a 12-pounder every 12 seconds, and a 3-pounder every 4½ seconds. The target was stationary; the distance known exactly; the speed known, and the sea presumably smooth. Consequently the errors of the gun-fire should have been almost entirely due to that part of the error of pointing which results from the use of ordinary sights and which I have stated, in my opinion, to be about one-fourth of a degree. Now a study of the diagram of hits, assuming that given by the Engineer to be correct, shows that the mean error of the Majestic's 12-inch guns was just about that much. If the mean error of pointing was one-fourth of a degree, or about 20 feet at the mean range of 1500 yards, then the percentage of hits, taking the

central portion, 80 feet by 24 feet, as the target, should have been about 34, and actually there were five hits out of 15 shots fired. Again it seems that practically all the hits of every caliber were within a length of about 160 feet, there being no hits near either extreme end, and this, on the well-known principle that the mean error is about one-third the extreme error, gives a mean lateral error of about 26 feet, reasonably to be accounted for by my assumed error of pointing and by imperfect correction for speed. The size of the vertical errors too can be judged somewhat from the fact that the masts were cut and splintered by numerous hits of small shell, almost to their very trucks. There appear to have been six or seven 12-inch hits, all but one in the central part, and probably 40 per cent of the 6-inch were also hits, and while this, in my opinion, shows most excellent marksmanship, it fully bears out what I have said about the error of pointing which inevitably results from the use of ordinary gun-sights. The result of 9 minutes' firing, even with the large error of pointing, shows what a modern ship's battery can do under favorable circumstances.

Let us see what results may be looked for under the ordinary conditions of service, supposing the mean errors of the guns at 2000 yards to be 24 feet vertically and 22 feet laterally as I have estimated them to be when telescope sights are used. We may assume as general dimensions of a hostile battleship a length of 375 feet, a freeboard of 25 feet and a beam of 75 feet, which, taking an angle of fall of our projectiles of a little over one degree, gives a vertical target 375 feet wide by 27 feet high for the broadside-on position, and 75 feet wide by 33 feet high for the end-on position. Taking first the broadside-on position of an opponent, I find with the foregoing data that the chance of hitting is 34, *i. e.* 34 per cent of all shot fired from the heavy guns will strike the enemy. With the same data, but with a range of 3000 yards instead of 2000 yards, and the errors of the gun increased proportionately, the percentage of hits would be about 22. Taking next the case of the end-on position of an opponent, here we have the lateral error of our gun-fire somewhat reduced by the elimination of that part of it due to the unknown speed of the target. I have assumed that the resultant of the motions of gun and target across the line of fire can be estimated with a mean error of four knots, which would result in a mean lateral error of the gun of 20 feet at 2000 yards range,

but, when the motion of the target is directly towards or away from the gun, one's own speed being known, this error should almost disappear. Consequently, in the case under consideration, while the mean vertical error of our guns is very slightly increased, say to 24½ feet, their mean lateral error is reduced, probably to 15 feet. With these data I find the chance of hitting at 2000 yards to be about 40 per cent, and at 3000 yards nearly 24 per cent.

If then I have made no seriously erroneous assumptions, the important conclusion is reached that within 3000 yards range a battleship offers a better target end-on than broadside-on, the ratio at 2000 yards being 20 to 17, and 24 to 22 at 3000 yards range. Of course the greater the errors of the gun, the more important is target *area* and the less important is the distribution of that area, and consequently as range increases the greater area of the broadside finally offers a better target than the higher, but much narrower and much smaller area of the end-on position, but the more accurate the gun-fire, and the less the range, the better the end-on target as compared with the broadside target. These figures seem to me to clearly indicate the proper course to pursue in an engagement with an opponent who endeavors to come to close quarters. Let us consider an action between two similar ships, each willing to fight, and suppose that A proposes to use his battery to its full effect, while B wishes to ram. If B simply stands directly for A, the latter brings B on his quarter, so as to have one whole battery in play and keeps him there by proper use of the helm. If A's speed equals or is superior to B's, this position can be maintained just as long as B is foolish enough to keep heading for A. If, however, B has the speed, then the time during which he remains exposed to A's full broadside, while only having his own ahead fire, is limited. Suppose B has 20 knots and A only 15 knots speed, and suppose the action began at 4000 yards range. Then B, heading for A, and being kept on A's quarter by the latter's slowly turning, will be approaching A at about 10 knots an hour, and to go from 4000 yards distance to actual contact will take over 12 minutes. Under such circumstances, in my opinion, A's proper course does not admit of question. He should trust to his gun-fire, and if he did not disable B in that 12 minutes, it would be a very remarkable thing. What more could be asked

than to have an enemy end-on for 12 minutes under your own maximum fire, at ranges steadily decreasing, and on a constant bearing, and, to cap the climax, to have your enemy meanwhile able to use but a fraction of his battery. Remember that B must actually reach A to bring the ram into play, and that as the distance diminishes, the percentage of hits for the guns rapidly rises.

Let A be the Kearsarge and B a five-knot faster Kentucky—during the 12 minutes approach A uses four 13-inch, four 8-inch and seven 5-inch guns against two 13-inch and two 8-inch for B—which would have the worst of it, and who can believe that B would not, long before reaching A, put his helm over and assume a more equal position. Of course this would be much more the case if a less difference of speed existed, as would be most likely. If I am right, then A's attitude, assumed because it gives him the maximum battery power, will compel B to relinquish the idea of ramming and to accept a test of battery against battery as A desires. Any other method of approach will keep B under A's full fire for longer than 12 minutes, and if B tries to keep his full battery bearing while approaching, over half an hour's gun-fire at decreasing ranges will have settled the action before the ram can come into play.

But doubtless you will say that such small errors, such large percentages of hits, as I have assumed to result when efficient telescope sights are used have never been found in past practice, nor is it likely that they will be in future, at least under battle conditions. Let us see if there are any reasons why we cannot expect to attain in practice the results deduced from theory, and first let us re-examine briefly the causes of error thus far discussed.

Considering first lateral errors, it is evident that the combined effects of accidental deflections due to the gun itself, of inclination of the axis of the trunnions due to rolling or pitching, and of wind across the line of fire, are unimportant.

In fact, their resultant is a lateral error of less than 6 feet at 2000 yards range, while the one remaining cause of lateral error—motion of gun and target—may easily introduce a mean error of 20 feet. Indeed, my assumed mean error of 20 feet supposes combined speed of gun and of target across the line of fire to have been estimated within four knots and allowed for in point-

ing, and, while this error may not be exceeded on the average, yet, if no attempt is made to estimate accurately and allow for motion of target across the line of fire, the error due to this cause is likely to be much greater than I have assumed. This, at all events, is the prime factor which determines the mean lateral error of gun-fire.

As far as vertical errors are concerned, there are two so great as to render all others insignificant. First and most important is the error due to motion of the ship during the interval between willing to fire and actually firing a gun. This error, if uncorrected, will have a mean value of some 63 feet, and consequently it is of the utmost importance to train the gun-pointers to allow for it. I have assumed that it can be corrected to one-third; so that its mean value will be only 21 feet, and that this excellence can be attained by the average gun-pointer as a result of training and practice I have no doubt.

Next in importance is the error due to incorrect measurement or estimation of the range. It is said that good judges can tell distances within 15 per cent, and if no instruments are used, I suppose that the mean error in range should be taken at 300 yards instead of the 100 yards I have assumed. If so, the vertical error due to this will be about 20 feet instead of 7 feet. If, however, as I think we must assume, there be some means of measuring range besides the unaided eye, a mean error of 7 feet is, in my opinion, an ample allowance for wrong setting of the sight bar, especially in view of the flatter trajectories of the latest type guns. This re-examination of our premises, then, has shown that the accuracy of naval gun-fire depends upon three factors: 1st, and most important, upon how closely the gun-pointers can allow for their personal errors; 2d, upon how accurately we can determine the range; and 3d, upon how nearly we can estimate and allow for speed of target across the line of fire. Provided reasonably efficient means are used to limit these three errors, the practical results of gun-fire under service conditions should not differ materially from the theoretical results which I have deduced. We can, then, I believe, attain such an excellency in gun-practice by dint of constant and intelligent effort that, even in the heat and excitement of battle, the percentage of hits will at least approach that which would result from the mean errors I have calculated; we need not, and I hope never again will, make such a poor showing as we did at Santiago.

Let us consider what conditions are necessary to attain this excellency.

1st. Every gun should be fitted with a telescope sight, and so fitted that it can be relied upon to remain in adjustment and not be thrown out by any number of firings of the gun itself. This can certainly be accomplished and will by itself remove one of the greatest causes of errors in gun-fire.

2d. Every gun-pointer must be taught to make a proper allowance for his personal error. It is very important that he should learn by constant practice to manipulate his gun with rapidity and accuracy, but above all he must learn by actual firing just when to try to fire in order that the line of sight may be on when he really fires. He must learn to really use the telescope sight; to keep his eye to it so as to see where the line of sight is when the gun goes off. One of the great causes of bad shooting is the drawing back of the gun-pointer from the telescope just as he fires, or even, in many cases, before firing. A rubber shield or cover for the eye-piece ought to sufficiently mitigate the effects of the backward jump of the telescope when the gun is fired to overcome the men's hesitation to keep their eyes near enough to see clearly at the actual moment of firing. Sub-caliber practice, under various conditions of the sea, and pointing and snapping primers at a target, should be of great value in training the gun-pointers to correct their personal errors. If the roll is considerable, and at all regular, accuracy of fire will be greatly increased by so pointing that the line of sight comes on near the end of the roll when the ship is almost stationary, and when suitable conditions exist, this method should be practiced, but motion in a seaway is usually so irregular that too much time would be lost in attempting it. The good marksman must be able to make an allowance suited to the greater or less speed with which his line of sight is approaching the target. Probably an average correction at 2000 yards range will result from willing to fire when the lower edge of the horizontal wire of the telescope reaches the upper line of the enemy's freeboard on a downward roll, or when the upper edge of the wire reaches his waterline on an upward roll, but each man must learn to make an allowance suited both to his own personal errors and to the rate of angular motion as his line of sight comes on.

3d. Officers, and gun-pointers too, should learn to estimate

and allow for the motion of the target across the line of fire, in order to reduce to a minimum the greatest cause of lateral error; and every available means should be used to accurately determine range, in order to similarly reduce the greatest *remaining* cause of vertical error.

As regards the estimation and correction for motion of target across the line of fire, I think it would be a great improvement to put marks on the horizontal wire of the telescope sight corresponding to speed corrections. This would enable the correction to be made within as close limits as the speed to be corrected for can be estimated. Of course the speed of one's own ship in action should be known, and the gun-pointer should be taught to make *accurate* allowance for it, and the speed of the enemy across the line of fire should be reduced to nothing, as far as possible. A nearly constant bearing of the enemy with respect to one's own course will add greatly to the efficiency of gun-fire, and to maintain such a constant bearing should be one of the most important objects of manœuvring in action.

I think it would be very desirable to develop this method in target practice by firing while steaming on a spiral course, either approaching or receding from the target. Under such conditions, were the target an opposing ship, there would be no error caused by his unknown speed, and the error caused by one's own speed would be a constant depending upon the angle which the course made with the line of bearing of the target, and consequently susceptible of previous calculation for any given speed and angle.

As regards measurement of distances, no thoroughly reliable range-finder has yet been devised, and the determinations made by a rapid-firing gun, though much better than mere judgment of the distance, are, in my opinion, almost certain to be greatly in error.

Perhaps the old telemeter in a more modern form would prove sufficiently accurate for such work. At all events, I hope it will be tried, and am sure that under some circumstances it would be of great value. I refer to the stop watch graduated in distances, by which the time interval between the flash and the report of a hostile gun is measured, and the corresponding distance read off. The objection is made to this device that it will be difficult to surely connect a given flash with the correspond-

ing sound, but by careful observation of the larger guns of an enemy, I should think this might be overcome. Certainly to a man shut up in a turret and cut off from outside information by any cause, this instrument might be of great value, as giving a possible means of measuring range.

But there is one more important means of adding to the efficiency of a ship's battery, and that is to so manœuvre her in action as to help the gunners, not so as to handicap them.

At Santiago, the necessity of preventing the escape of an enemy supposed to be of superior speed, caused the adoption of tactics which could not but have a most injurious effect upon the accuracy of our gun-fire.

During the first and most important part of the engagement, when the Spanish ships were coming out and our ships were gathering way and increasing speed as rapidly as possible, the distances changed with such rapidity that I have no doubt but that the gun-sights were set with a mean error of many hundred yards. Moreover, the course of the enemy, his unknown speed, our own varying speed and rapid turning under the action of the helm must have introduced great lateral errors. These facts, together with the imperfections of the sighting apparatus, the smoke, and the unexpectedness of the sortie combined to affect the accuracy of our fire and account for the remarkably small percentage of hits. Who can doubt that an enormous increase in this percentage of hits would have resulted from a change in conditions which allowed of a steady bearing and a constant or slowly varying range of the enemy?

The advantages which come from keeping the enemy on a bearing which makes a constant angle with our own course are greater, perhaps, than would appear at first sight. In the first place the lateral error due to the unknown speed and course of the enemy is entirely eliminated. But, secondly, the angle of train being constant, the firing will be more rapid and more accurate, for the reason that the line of sight will pass across the target at each roll, thus enabling the gun-pointer to pay entire attention to his elevation. With a constantly changing bearing of the enemy, on the other hand, if the line of sight comes on in train at one roll, it is likely to be entirely off the target at the next, and the gun-pointer has the doubly difficult task of simultaneously adjusting both train and elevation.

A constant, or at least but slowly changing, distance, too, is a great help to accurate gun-fire, as it enables the range to be estimated and the firing corrected by observation of the points of fall of the shot.

Of course an equal advantage accrues to one's opponent from such conditions, and where an enemy trusts equally with oneself to his battery, and asks nothing better than to oppose broadside to broadside, it may be a question whether to accept the gage or, by manœuvring, to endeavor to gain some advantage of position. But it is when the enemy, trusting to other weapons, fails to take the equal advantage which lies open to him, that the opportunity comes to develop one's gun-fire to its maximum by manœuvring solely with a view to *its* efficiency. The skill and discipline of the men behind the guns, the results of constant and unsparing efforts in preparation for the decisive moment of action must always be the principal factors in success, but the skill with which the commanding officer handles his ship so as to keep the maximum number of guns in play; to keep the enemy on as nearly constant a bearing as possible; and to avoid rapid changes of distance, will give victory over an otherwise equal opponent.

[NOTE.—Discussion on this article is invited, to be published in succeeding numbers.—EDITOR.]

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

OUR NEW BATTLESHIPS AND ARMORED CRUISERS.

By D. W. TAYLOR, Naval Constructor, U. S. N.

The six armored cruisers and five battleships for which bids were advertised to be opened on December 7, 1900, not only constitute the largest single addition to our armored ships ever advertised for at one time, but each one of these eleven vessels is larger than any vessel of our navy now built or building.

The following remarks refer entirely to the designs prepared by the department. The bidders are allowed to submit their own designs and incorporate in them any and all features of the department's designs. With the advantage of full information concerning the department's designs to start with, and a free hand, in some respects, where the department's designers are handicapped, it is to be hoped that the contracts will be ultimately awarded for vessels somewhat superior to those herein described.

Figs. 1, 2 and 3 show the general features of the eleven armored vessels in question, and Table I gives their dimensions and various other data concerning them. Three of the battleships are to be sheathed and two unsheathed. In view of the department's decision that three of them should have two superimposed 8-inch turrets and the other two the 8-inch turrets in a quadrilateral arrangement, the superimposed arrangement was applied to the three sheathed battleships. As the sheathed and unsheathed armored cruisers are alike in every particular, except as to the sheathing and the minor differences in stem, stern post and other fittings incident to sheathing, it is not thought necessary to give separate plans for the sheathed and unsheathed vessels.

The most obvious fact in connection with these vessels is their very great size as compared with any of our earlier vessels of

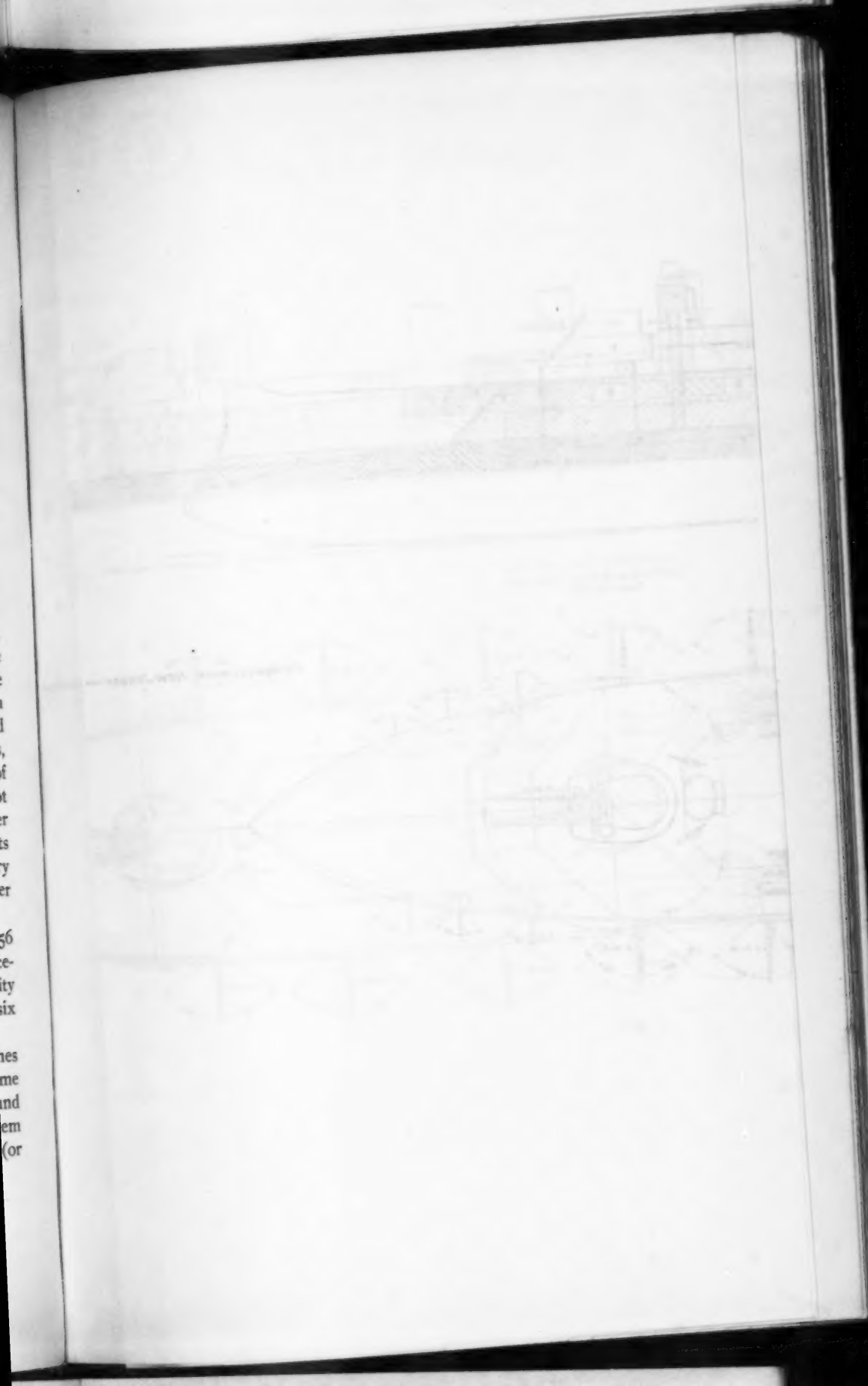
similar types. Our last armored cruiser was the Brooklyn, of 9215 tons displacement; whereas the Maryland class are of 13,400 tons. The three vessels of the Maine class, our last battleships, are all under 12,500 tons displacement, while the new unsheathed battleships are 14,600 tons.

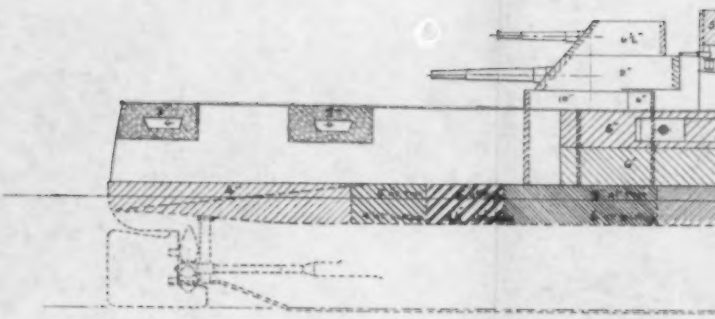
When we come to compare these battleships and armored cruisers—not with our former vessels, but with each other—the question at once arises whether it is worth while to continue to build armored cruisers inferior to battleships in so many respects and superior to them in so few. Some light upon this question may be afforded by a consideration of the genesis and the development of the armored cruiser.

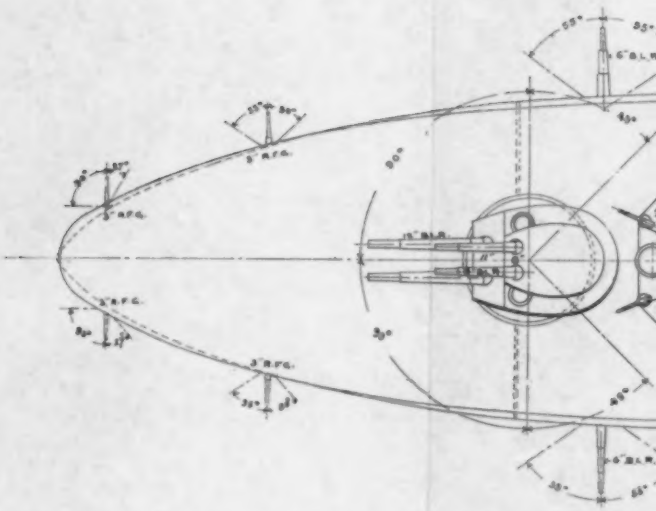
I believe the first armored cruisers were the Imperieuse and Warspite, in the English navy. These vessels were designed in the early '80's as "Armor-plated Cruising Ships." They were sheathed and coppered, had a large amount of sail power, and while properly classed as "Armored Cruisers," they can hardly be regarded as the forerunners of the armored cruisers of to-day. I think that the first vessels designed with a view to fulfilling the functions expected to-day of the armored cruisers, were the seven English belted cruisers of the Aurora class, completed in 1888 and 1889. These vessels were often called the belted Merseys—following after the four vessels of the Mersey class, completed about four years before them. The vessels of the Mersey class were protected cruisers, 300 feet long, 46 foot beam, having a little less than 20 feet mean draught, a little over 4000 tons displacement, about 6000 H. P., and about 17 knots speed. They had a coal capacity of 900 tons. Their battery consisted of two 8-inch, ten 6-inch, three 6-pounders, and smaller guns.

The seven vessels of the Aurora class were 300 feet long, 56 foot beam, 22 feet 6 inches mean draught, 5600 tons displacement 8500 I. H. P., speed a little over 18 knots, coal capacity 900 tons, armament, two 9.2-inch guns, ten 6-inch guns, six 6-pounders, ten 3-pounders, and other minor guns.

The Mersey class had a protective deck from 3 to 2 inches thick, and no armor. The Aurora class had about the same deck protection, but carried a 10-inch partial belt of compound armor, and some armor protecting the guns. Comparing them with the Mersey class they would seem to have 1600 tons (or







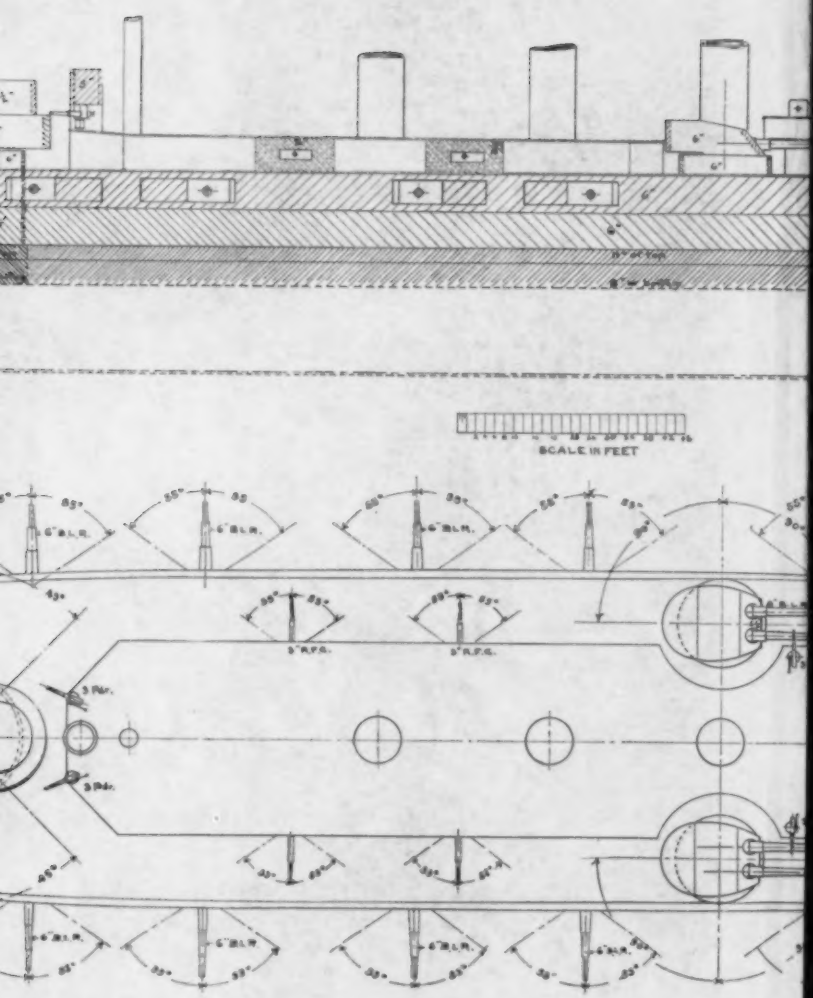
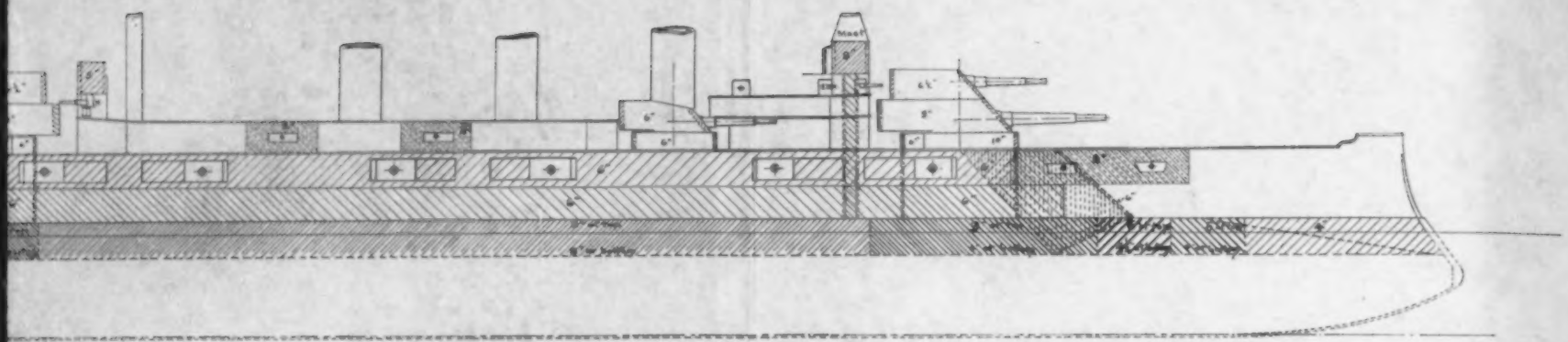
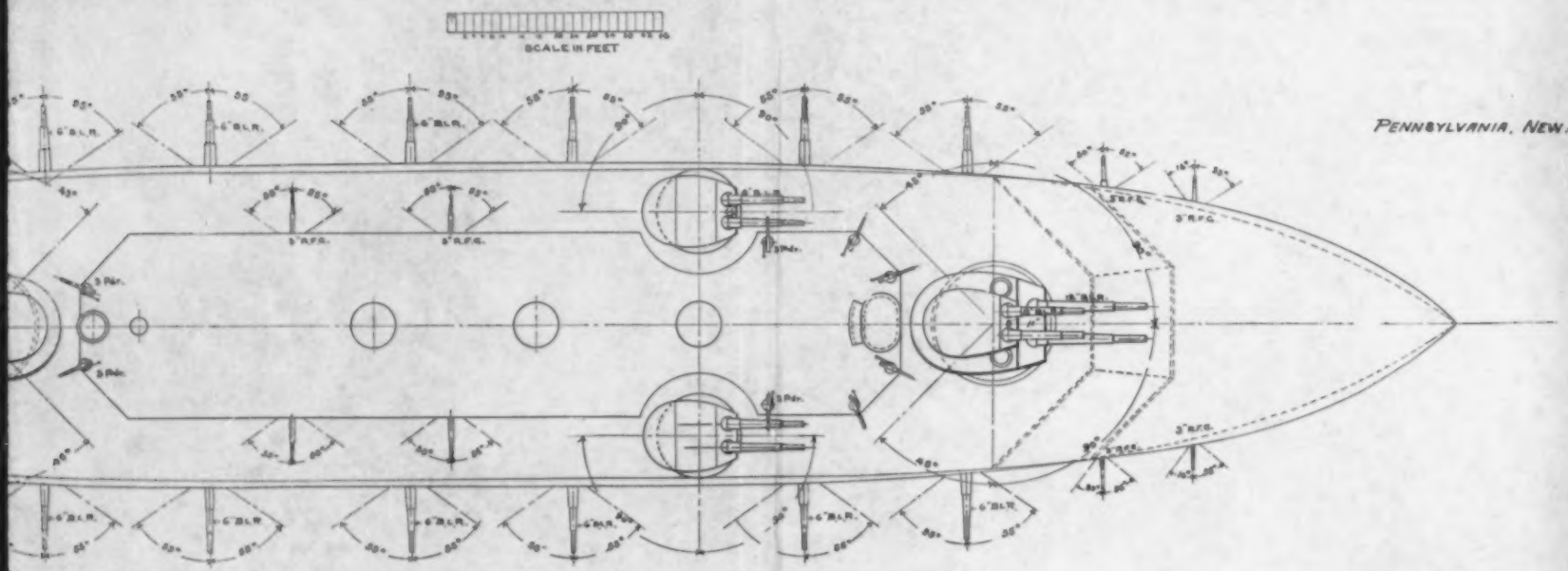


FIG. 1.





PENNSYLVANIA, NEW JERSEY and GEORGI

FIG. 1.

nearly 40 per cent) greater displacement, to have more than a knot greater speed, the same coal capacity, and a materially heavier battery and armor protection. They cost about 30 per cent more. Clearly, these vessels could be expected to find their greatest field of usefulness in attacking and destroying the protected cruisers of the day, which were smaller, weaker and slower.

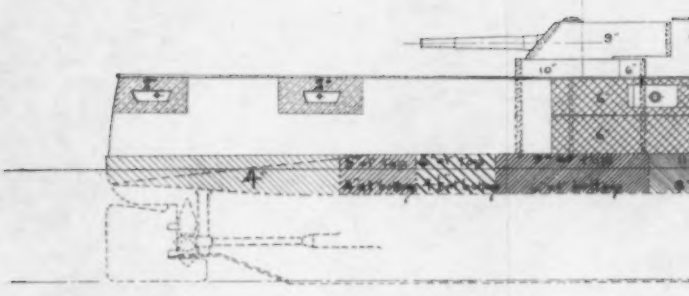
As the type developed and the size of protected cruisers increased, it became more and more difficult to build armored cruisers which would be superior to the protected cruisers in armor, armament, and speed. The speed dropped back until it was less than that of the protected cruiser. An illustration of this is furnished by our own navy, when comparing the New York and Brooklyn and the Columbia and Minneapolis, of almost the same date. The armored cruiser then came to be regarded as a light, fast battleship, a vessel smaller and handier than the battleship, having less battery and armor, but making up for this defect by superiority in speed and coal endurance. In its latest development the armored cruiser has increased in size until it is practically as large as the battleship, and it would appear that the time is now about ripe for the settlement of the question whether the type shall survive or be merged into the battleship proper.

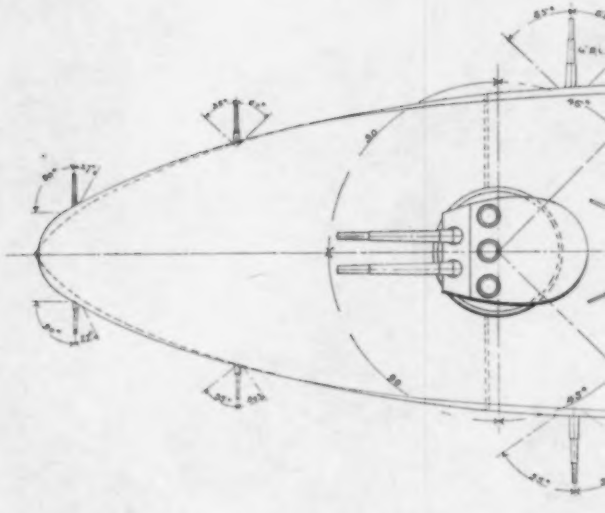
Compare, for instance, the vessels of the Maryland class with the Virginia and Rhode Island (Table I). The Maryland has but 8 per cent less displacement than the Virginia. She is 15 per cent longer, and has slightly greater freeboard—offering a larger target. She draws 6 inches more water. She is decidedly inferior as regards the battery and its protection, carrying about 840 tons of battery and ammunition (with full supply of ammunition), as against 1417 for the Virginia. The armor on her side is not only thinner, but has a less extent, absolutely, and a very much less extent, relatively, considering the side of each vessel. From the water-line to the main deck the Maryland has 4355 feet, or 45 per cent covered by armor; the Virginia has 4775 feet, or 60 per cent covered by armor. The total weight of armor on the Maryland is a little over 2000 tons, as against more than 3400 on the Virginia. The bunker capacity of the Maryland is 2000 tons, as against 1900 for the Virginia—a gain of more than 5 per cent. But as the Maryland has nearly 2 per cent greater wetted surface than the Virginia, and as her more powerful engines will waste more in friction at a 10-knot speed

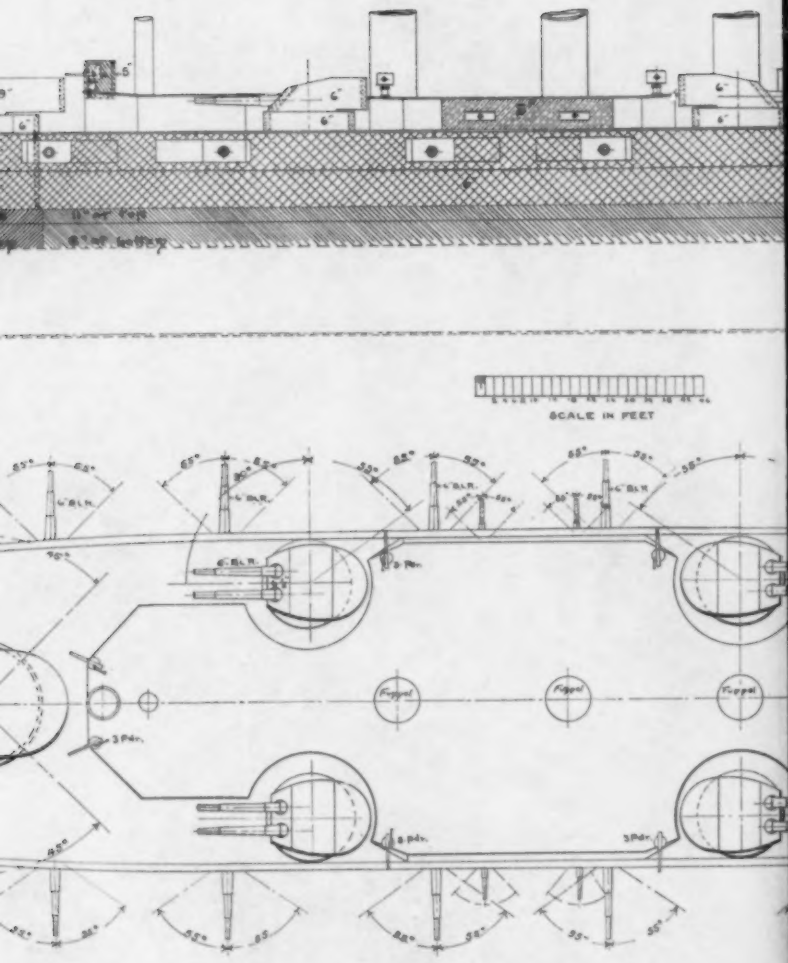
than those of the battleship, it may be said that the two have practically the same coal endurance at 10 knots. The sole point of superiority of the Maryland is the 3 knots greater trial speed —22 as against 19. In this connection, it may be desirable to attempt to appraise the advantage the Maryland may be expected to have over the Virginia in speed in other than trial conditions. Evidently, under the same conditions each may be expected to develop the same fraction of its maximum indicated horsepower. While the indicated horsepower curves of these vessels are not yet known, they can be estimated fairly well from experiments made at the model basin, and from such experiments the diagram shown in Fig. 4 has been determined. The estimated maximum indicated horsepower in each case is reduced to a line of the same length and speed curves drawn with fractions of maximum I. H. P. as abscissæ and speed as ordinates.

All things considered, it appears probable that under the conditions of service a man-of-war cannot expect to average for a long period of time, say seven or eight days, more than from 50 to 60 per cent of the maximum I. H. P. maintained on trial. Under these conditions the Maryland would have about 2 knots advantage in speed over the Virginia, while for a short spurt she may reasonably be expected to maintain the 3 knots of the original trial.

Probably some members of the Institute may be surprised that the Maryland, so nearly the same size as the Virginia and superior only as to speed, should be so inferior in other respects. The general tendency is to regard the question merely as one of weights; that is to say, if it were desired to make the Iowa a 19-knot ship it would simply be necessary to reduce the weight of battery and armor and put it into machinery. As a matter of fact, it would be necessary to assign not only greater weight to the machinery, but greater space, rendering it necessary to lengthen the vessel, and indirectly causing much more weight to be carried than the additional machinery. The estimated weight of the machinery of the Virginia is 1796 tons; that of the Maryland is 2135 tons; or but 339 tons more. Owing largely to the greater length, however, the hull of the Maryland, including the protective deck, weighs nearly 400 tons more than that of the Virginia. The Virginia, then, being 1200 tons smaller, has to carry more than 700 tons greater weight of hull and machinery. The coal and miscellaneous weights are practically the same, so that







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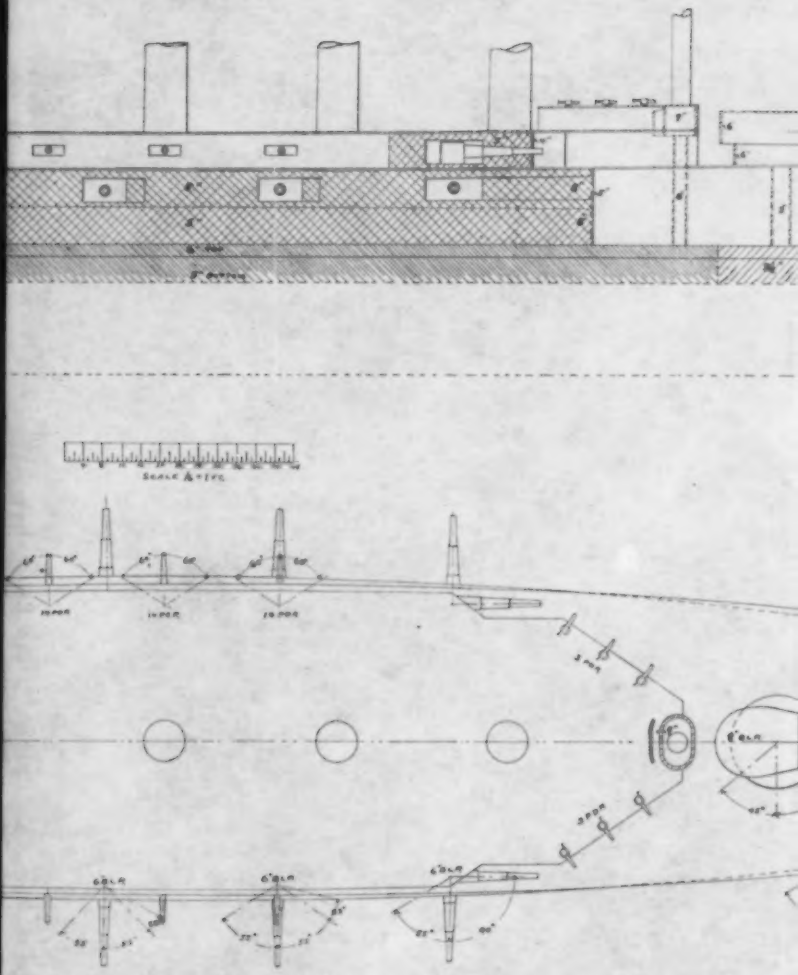
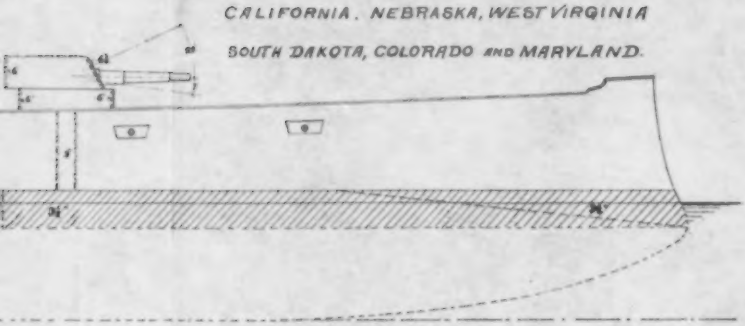


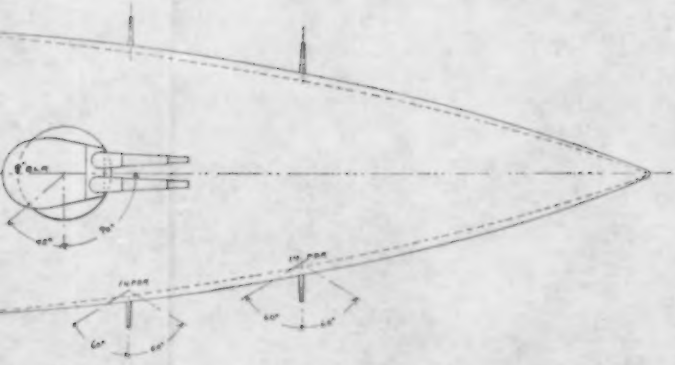
FIG. 3.

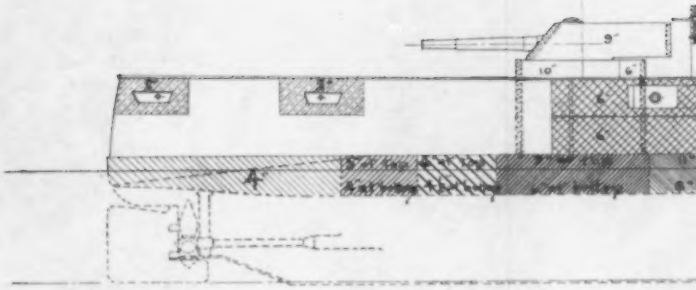
U. S. ARMORED CRUISERS

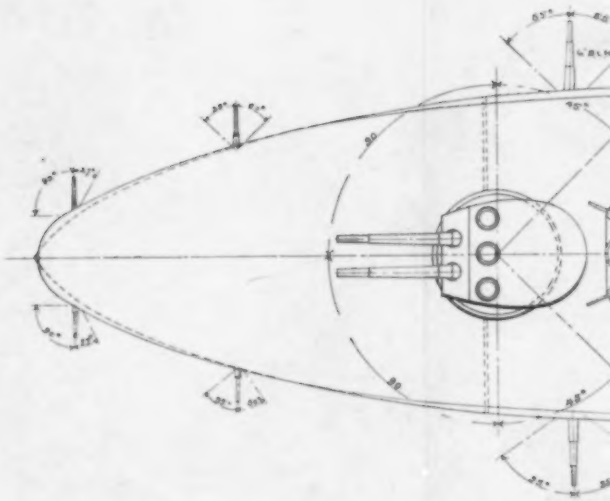
CALIFORNIA, NEBRASKA, WEST VIRGINIA

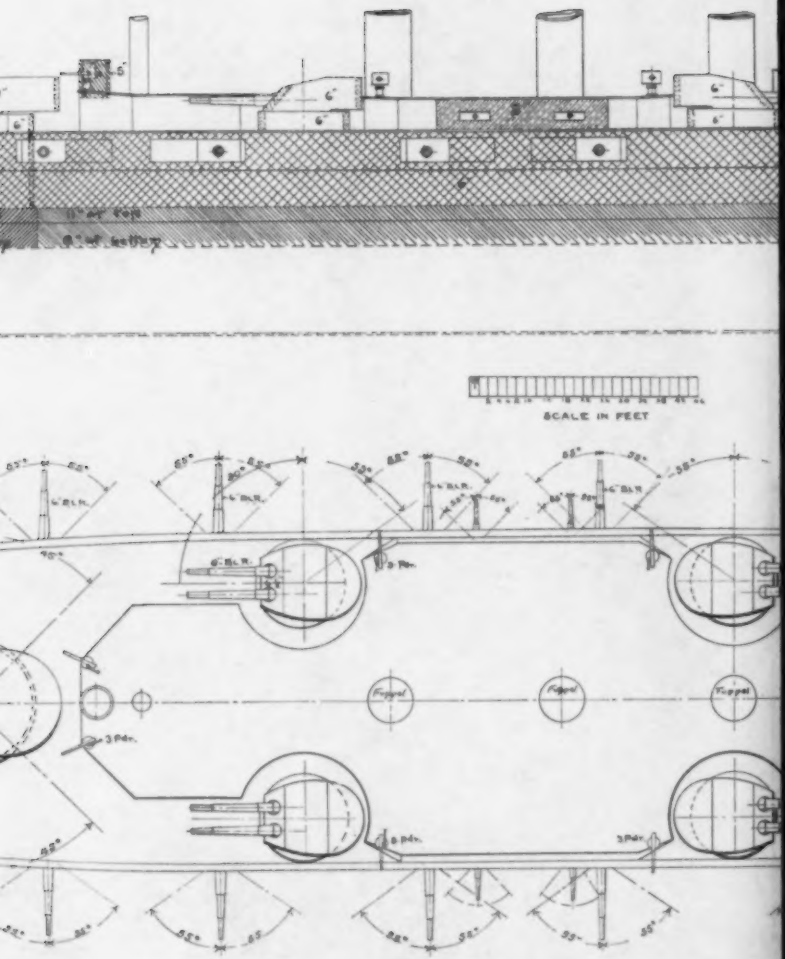
SOUTH DAKOTA, COLORADO AND MARYLAND.











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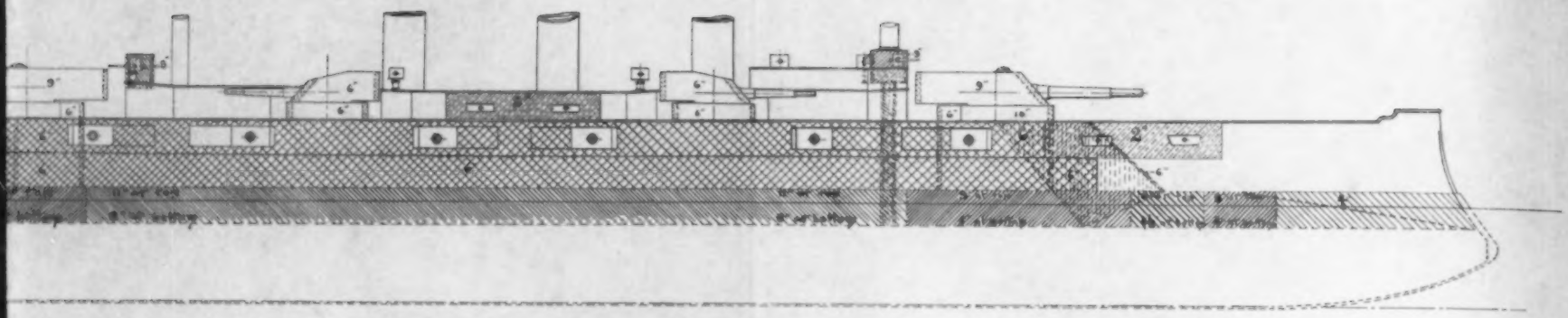
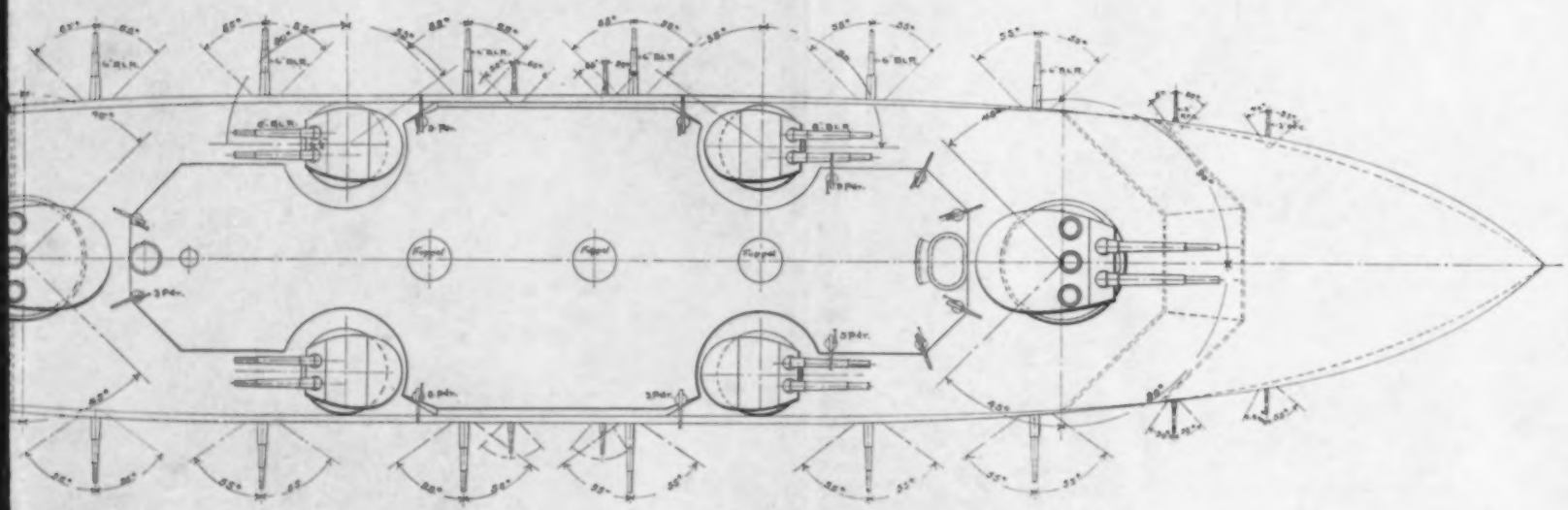


VIRGINIA and RHODE ISLAND.



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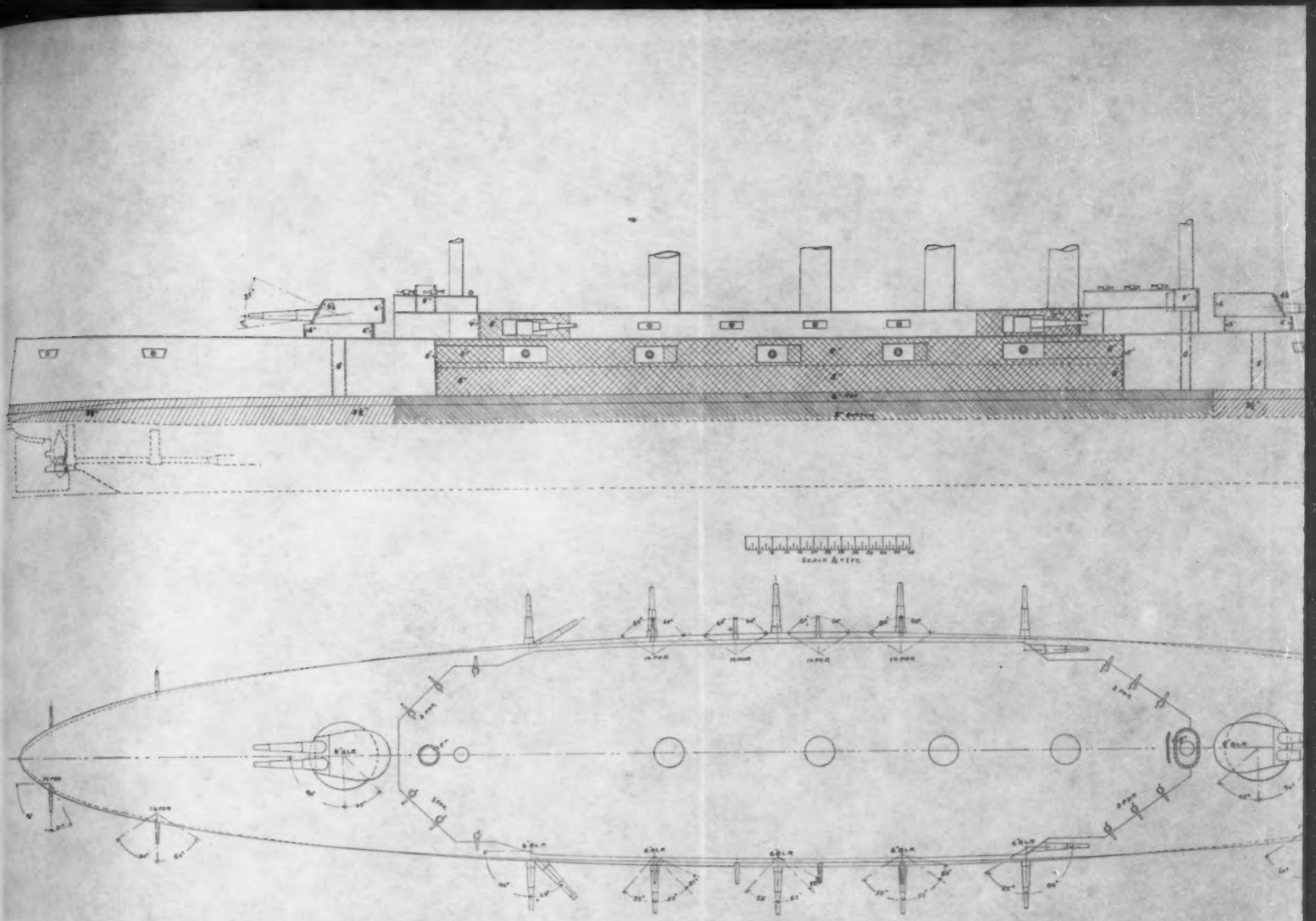

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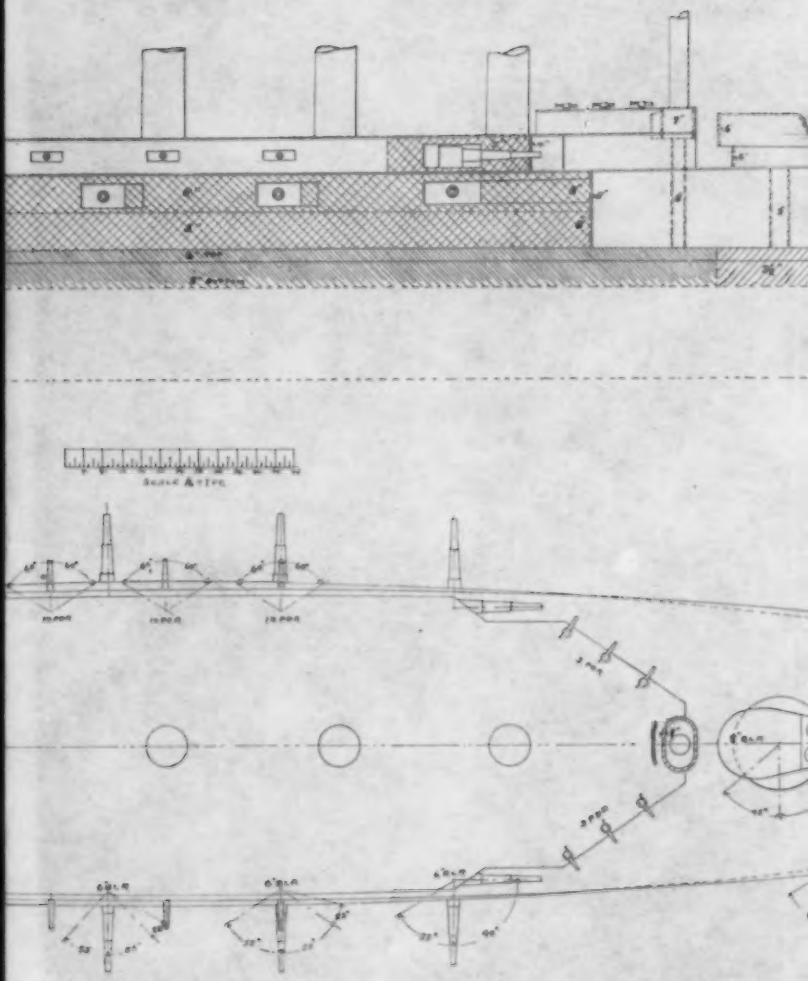
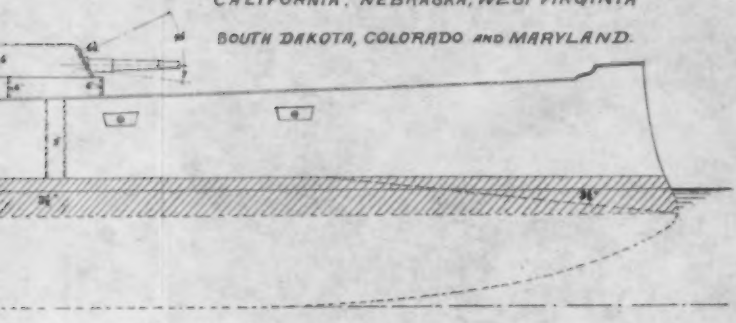


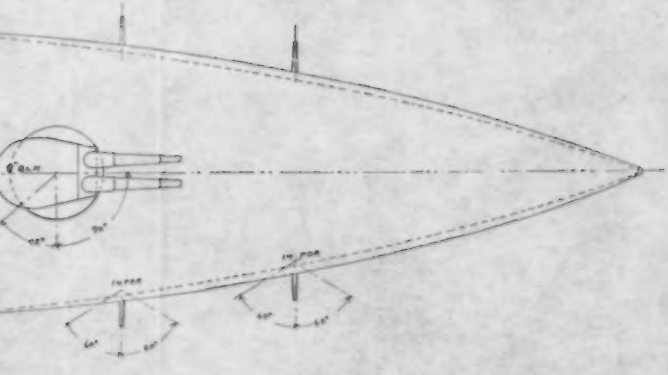
FIG. 3.

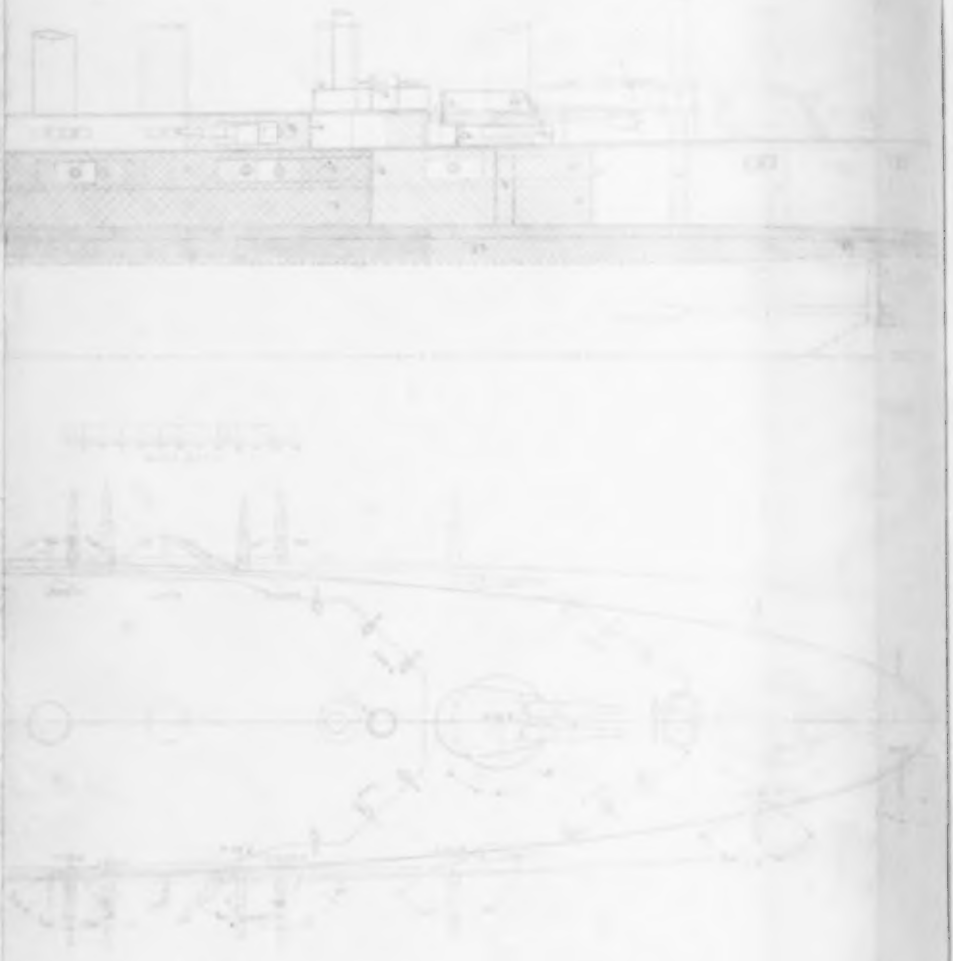
U. S. ARMORED CRUISERS

CALIFORNIA, NEBRASKA, WEST VIRGINIA

SOUTH DAKOTA, COLORADO AND MARYLAND.







the Maryland class must carry about 1900 tons less of armament, ammunition, and armor. At normal displacement, the total weight of armament, ammunition (two-thirds full supply) and armor is 1912 tons less upon the Maryland than upon the Virginia, according to present estimates.

After careful consideration of these two types, it seems to me that the time has come to ask some such questions as the following:

First.—Taking into account the fact that with the completion of ships now authorized we shall have six large armored cruisers of 22 knots speed and five smaller ones of practically the same speed,[1] are we warranted in continuing to build at the same time vessels of so nearly the same size and cost, and differing so widely in other respects, as the Maryland and Virginia?

Second.—If the superior speed of the armored cruisers is of such value as to warrant our continuing to build Marylands side by side with Virginias, would it not be more consistent and logical to increase again the speed of the battleship to, say, 21 knots, without reducing its offensive or defensive powers? This would involve a material increase in size, probably to 1700 tons or so trial displacement, and an increase in cost of probably 12 to 15 per cent.

Put into another form the questions above may be reduced to one.

For a given expenditure of money we can probably build four Virginias and five Marylands, or eight Virginias, or seven enlarged Virginias of 21 knots trial speed. At the present time which course would be the best to follow?

This question must be answered ultimately by the sea-going officers of the service. This paper will have served its purpose if it results in bringing out the views of some of the many officers whose views have the weight of authority. It is earnestly to be hoped that the development of the navy during the next five years will not be along lines which will be generally recognized as not the best at the end of that period.

NOTE.—Discussion on this article is invited, to be published in succeeding numbers.—EDITOR.

[1] NOTE—I include as armored cruisers the three protected cruisers now advertised by the department, because they are practically improved Brooklyns.

TABLE I.—DATA FOR BATTLESHIPS AND ARMORED CRUISERS.

	BATTLESHIPS.		ARMORED CRUISERS.	
	Pennsylvania, New Jersey. Georgia. (Sheathed.)	Virginia, Rhode Island.	California, Nebraska, West Virginia. (Sheathed.)	Maryland, Colorado, South Dakota.
Length on load water line	435′	435′	502′	502′
Length over all	441′ 4″	441′ 4″	504′ 9″	504′ 9″
Beam extreme	76′ 10″	76′ 2⅛″	70′	69′ 6″
Draught mean trial	24′	24′	24′ 6″	24′ 6″
Displacement in tons, normal	15000	14600	13800	13400
Speed on trial, estimated knots	19	19	22	22
Indicated horse power on trial (Est.)	19000	19000	23000	23000
Freeboard forward, normal	20′	20′	23′	23′
Freeboard aft, normal	19′ 3″	19′ 3″	21′ 6″	21′ 6″
Wetted surface, sq. ft.	42313	41800	42843	42430
Deep load draught, mean	26′	26′	26′ 6″	26′ 6″
Armament—				
Main battery	4 12″ B. L. R. 8 8″ B. L. R. 12 6″ R. F.	Same as sheathed battleships.	4 8″ B. L. R. 14 6″ R. F.	Same as sheathed cruisers.
Secondary battery	12 14-pdr. R. F. 12 3-pdr. R. F. 4 1-pdr. (Aut.) 4 1-pdr. R. F. 2 mach. guns 6 Colt (Aut.) 2 3″ R.F. field		18 14-pdr. R. F. 12 3-pdr. R. F. 4 1-pdr. (Aut.) 4 1-pdr. R. F. 2 mach. guns 6 Colt (Aut.) 2 3″ R. F. field	
Torpedo tubes	2 submerged	2 submerged	2 submerged	2 submerged
Heavy guns forward, above L. W. L.	12″—26′	12″—26′	8″—26′ 3″	8″—26′ 3″
Heavy guns aft, above L. W. L.	12″—26′	12″—26′	8″—26′ 3″	8″—26′ 3″
Thickness of W. L. belt amidships, top	11″	11″	6″	6″
Thickness of W. L. belt amidships, bottom	8″	8″	5″	5″
Total depth of belt	8′	8′	7′ 6″	7′ 6″
Thickness lower casemate	6″	6″	5″	5″
Thickness upper casemate	6″	6″	5″	5″
Thickness of fronts heaviest turrets	11″	11″	6½″	6½″
Thickness of sides heaviest turrets	9″	9″	6″	6″
Thickness of slopes of protective deck	3″	3″	4″	4″
Thickness of flat of protective deck	1½″	1½″	1½″	1½″

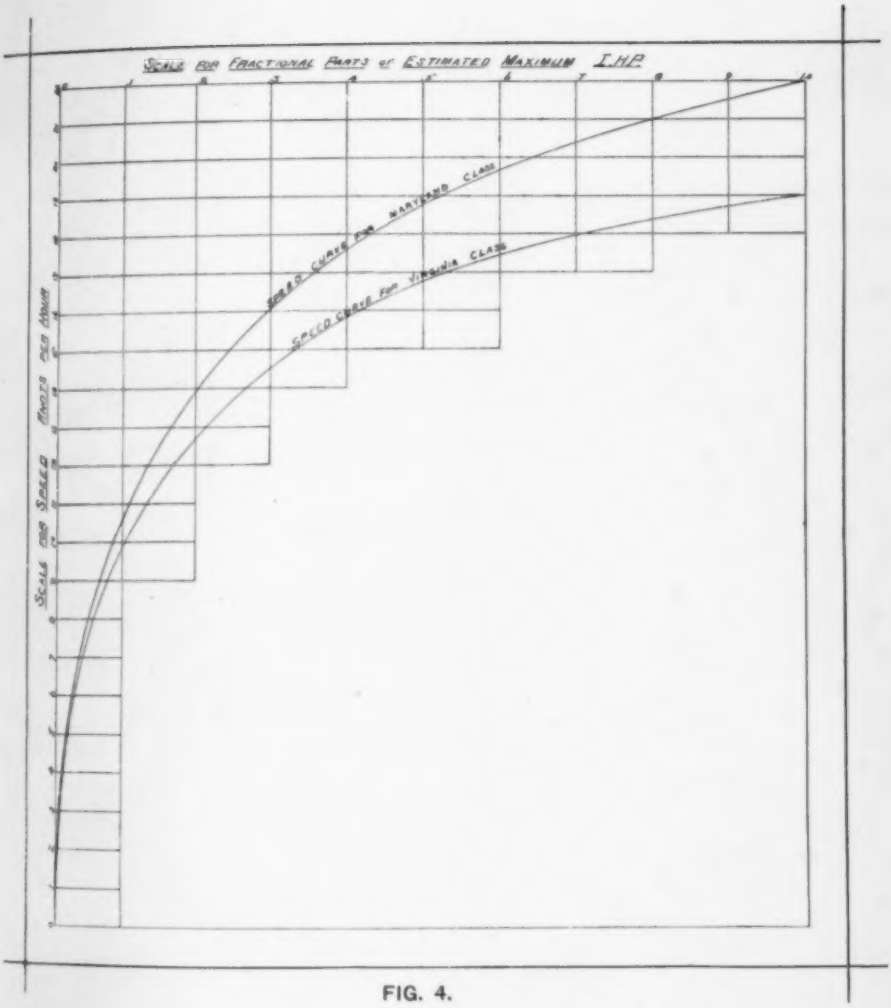

Scale for Fractional Parts of Estimated Maximum I.H.P.
Scale for Speed Knots per Hour
Speed Curve for Maryland Class
Speed Curve for Virginia Class

FIG. 4.

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THE INFLUENCE OF SUBMARINE CABLES UPON MILITARY AND NAVAL SUPREMACY.

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The accidental non-delivery of two cable messages from the Minister of Marine (Bormejo) to the commander-in-chief of the Spanish squadron (Cervera), at Martinique, undoubtedly largely changed the whole history of the Spanish-American war.

One of these telegrams informed the Admiral of coal supply near at hand, and the other granted him permission to return at once, with his squadron, to Spain.

Admiral Cervera's firm stand against the dispatch of the Spanish squadron from the coast of Spain to West Indian waters is heroically and almost pathetically shown in the recent publication, by permission of the Queen Regent, of the official despatches. At Cape Verde, and before and after, by cable and by letter, he points out the unpreparedness of his squadron, and predicts its certain destruction if it proceeds. Knowing his strong views on this point, it is probable that he would have lost no time in coaling and starting back to Spain.

With Cervera's squadron returned to Spain, there would have been no Santiago campaign, the Flying Squadron would probably have been sent to the coast of Spain, and the land operations in Cuba directed against Havana.

Cervera's fleet not eliminated, who can say how long Spain may not have been able to resist, and what additional blood and treasure the struggle may have cost the United States.

The story of the Spanish-American war is largely a story of "coal and cables." That war for the first time demonstrated the dominating influence of submarine cable communications in

the conduct of a naval war. As a result of it, the principal maritime powers, with colonial possessions, are each at present elaborating their "Cable Policy," and have awakened to a realization of the fact that reliable submarine communications under exclusive control are not only absolutely necessary, but exercise a dominating influence upon the control of the seas, whether in commercial strategy or in military and naval strategy.

A modern war between two naval powers has reduced itself largely to a war of "coal and cables."

At present the submarine telegraph is a powerful instrument of war, more powerful, indeed, than battleships and cruisers, since by wonderful and instantaneous communications of thought, it brings distant countries and colonies together in sympathy, which is the only true and permanent tie.

Electricity the Ideal Means of Transmitting Intelligence.

The triumphs of science in the last half century have been no where more exemplified than in the enormous strides made in the facility of transmitting intelligence. The mails, the telegraph, and the telephone are civilizing the world. Perfect as is the mail system of to-day, a monument to organization, yet, its swiftest messenger—steam—is so far outstripped either on land or sea by the practically instantaneous electric current, that the tendency year by year is to put more of the world's business "upon the wire."

Time has an international money value in trade, and a paramount strategic value in war. The fastest mail express, or the swiftest ocean ship, are as naught compared with the velocity of the electrical impulse, which practically annihilates any terrestrial dimension. As the distance increases, electricity surpasses steam in a continuously increasing ratio. With a message to be sent half way around the earth, the minutes required by the telegraph, run into weeks and months by the slow process of the mails. Steam time is directly a function of the distance to be traversed, and from the nature of things must require twice as long to go two miles as one. If, then, the cable saves six days between Europe and America, it will save more than twice this time between America and the East, and is from this point of view correspondingly important and necessary. Since elec-

tricity so far outstrips any other known vehicle for transmitting intelligence, it must eventually carry all the most important of the world's information.

Strategy has been defined as, the science of combining and employing the means which the different branches of the art of war afford, for the purpose of forming projects of operations and of directing great military or naval movements; the art of moving troops or ships so as to be enabled either to dispense with a battle or to deliver one with the greatest advantage and with the most decisive results.

* * * * * * * * *

It is believed that the more the foundations of successful strategy are analyzed, both as the science of conceiving military plans and as the art of executing the same, the more it will become clear that the strategist who is possessed of the most efficient and reliable means of obtaining and communicating information, both of the enemy and his own forces, will have a paramount and insuperable advantage.

Maritime nations are at present beginning to realize that it is not ships and coaling stations alone which measure naval strength, but also reliable and efficient means of directing, concentrating, supplying, or withdrawing those ships upon the great strategic chess board of the sea.

Lord Charles Beresford, in January, 1888, declared that, in time of war, the cutting of cables would make it impossible for chiefs of squadrons of distant stations to receive communication of the plan of campaign, and that they would no longer know where to find coal nor upon what protection to count.

Nor is this means required for securing true information only, but also for the equally important rôle of disseminating misinformation, since deceiving the enemy has always been an important means of strategy.

If there have been any doubts of the dominant influence of land and submarine cable communications as a military and naval necessity, they would be completely dispelled by the present unparalled situation in China, in which the rest of the entire world has been kept in ignorance for a period of a whole month, by the lack of adequate communications under control.

As a means of communication over great distances at sea, nothing compares, at the present state of practical science, with

the submarine cable. The nation with exclusively controlled submarine communications, not possessed by an adversary, has an organized service of surveillance, which is not only important during actual war, but which may and will prove a powerful weapon in the diplomatic and preparatory conflict, which always precedes a declaration of war, and these communications are a means of securing a first *real victory*, even before war has been formally declared.

It may be said, therefore, *that the very foundation of successful naval strategy is efficient and exclusively controlled communications, and the lack of them more serious than inferiority in ships.*

As soon as the possibility of communicating at long distance, by means of submarine cables, was practically demonstrated, England understood what commercial and political preponderance the creation of a great network of cables, resting under her control, would give her.

Without letting herself be discouraged by heavy losses in the beginning, with a perseverance worthy of admiration, she has succeeded in creating and developing, methodically and without delay, a network of submarine telegraphic cables, which to-day encircles a large part of the entire world.

The English cables, up to the present, have been laid principally by private companies, but Article 7, of the conditions which govern them, provides that all official despatches shall have precedence over others; Article 3, that the companies can have no foreigners among their employees, nor can the wires pass into a foreign office, nor under the control of a foreign government, and Article 9, that in case of war the government can occupy the different stations and place its own employees therein.

During the past two years, however, there has been a great national protest in England and her colonies against the exorbitant rates imposed by the monopoly of the private cable corporations, until the principle of absolute state ownership has come to be a controlling one in England's future cable policy.

The Imperial Cable System of Great Britain.

England's sea power is not alone measured by the number, character and tonnage of her warships, it is immensely increased by the system of exclusively controlled submarine cable network, at present including nearly four-fifths of all the cables in the

world, woven like a spider's web to include all her principal colonies, fortified ports, and coaling stations.

Although submarine cable communication is scarcely fifty years old, yet the British Empire is already bound together in one vast intelligence transmission system, with London as its center. Nothing important can happen at any quarter of the globe which does not find its way to this great world's news exchange—London. And this system is and has been a principal element of her strength, and has largely made possible a government including subjects naturally widely differing in character, habits, and modes of thought.

The colonist in New Zealand or in British Columbia can read each morning what was said in Parliament the day previous upon any subject important to British interests.

This great cable system, as at present existing, is the more important from our present standpoint, since no other country has such a system, and this fact has placed in the hands of the British Empire a powerful means of real dominion over the rest of the world. Nor is England satisfied with her present extensive telegraph system of world control, she has in projection for the very near future, an extension of this system, which will be nothing less than a British imperial telegraph system encircling the entire globe.

A pioneer advocate of a British imperial cable system has been Sir Sandford Fleming of Canada.

It was early discovered by every country in Europe that so efficient and valuable a servant to trade and commerce, so important an aid to the state itself, as the telegraph, should become a national institution. Great Britain, France, Austria, Prussia, Russia, Sardinia, Italy, Spain, Portugal, and Belgium, each established a state telegraph system. Thirty years ago the English telegraph lines were transferred to the state, and experience has shown that this has been done with advantage to the state itself and benefit to the public at large. At the present moment the British Empire is advancing rapidly to the accomplishment of a state controlled cable system. Imperial penny postage having been recently realized throughout the British Empire, the next great step in imperial development along this line is to connect the state-owned land telegraph systems of the Empire by a state-owned and controlled system of submarine cables. An essential

and necessary condition which has guided in the conception and realization of this cable system, has been that none of the lines shall touch foreign soil. So important has been this principle in the proposed British-Pacific cable, that we find Great Britain, for some years past, anxiously negotiating for sovereignty over an insignificant island in the Hawaiian Group upon which to land her proposed cable to Australasia; and failing in this, we find her boldly ready to lay a single span of cable of over 3500 nautical miles in length, from Vancouver to Fanning Island, for the sole imperial reason that the cable shall touch only soil exclusively owned and controlled by Great Britain. This principle will be bought, in this case, at the price of permanently placing at a disadvantage British cable traffic in the Pacific; since, as will be pointed out later, the United States, by the annexation of the Hawaiian Islands, can reach the East across the mid-Pacific by cables having no single span longer than the present Atlantic cables, and yet adhere to the same principle of landing only on territory belonging to the United States.

British Pacific Cable.

England at present has direct telegraphic connection with Vancouver, with wires independent of any foreign power, since practically all of the Atlantic cables landing at Newfoundland, or Nova Scotia, from the coast of Ireland, are under British influence, and in connection with the Canadian Pacific telegraphic lines, therefore, furnish England with direct communication to the west coast of North America.

The proposed British-Pacific cable has been prominently before the British government as an imperial measure for a number of years. It has been the subject of colonial conferences, and of exhaustive research by a Pacific Cable Commission. Its construction is now assured beyond a reasonable doubt. The route is from Vancouver to Fanning Island, thence to Fiji Island, thence to Norfolk Island, and from thence by two branches to New Zealand and the eastern coast of Australia. The land lines of Australia would then complete telegraph connection with the western coast. In the Indian Ocean it is proposed to connect West Australia to Cocos Island, and then to Mauritius, and from thence to Natal and Cape Town. Cocos Island is further to be connected with Singapore by a branch cable. Singapore being

already in connection with Hongkong by an all-British cable. Another branch is also proposed from Cocos to Ceylon. At Mauritius a connection would be formed with the existing cable at Seychelles, Aden, and Bombay. In the Atlantic Ocean, in order to avoid the shallow seas along the west coast of Africa, Spain, Portugal, and France, a cable from Cape Town, touching at St. Helena, Ascension, and St. Vincent as mid-ocean stations has been laid within the last few months. Its construction was hastened after the outbreak of the Boer war, to furnish an alternate British route to South Africa by the West Coast. It is further proposed to extend the cable from Ascension to the British Island of Bermuda, perhaps touching at Barbados, as a mid-ocean station.

At Bermuda a connection would be formed with the cable already existing to Halifax, and at the latter point with the Canadian and trans-Atlantic lines. The extension of the above cables in the Pacific, the Indian, and the Atlantic Oceans, would involve the expenditure of something like £6,000,000 sterling, and the laying of about 23,000 knots of new cable. With the equipment and experience which Great Britain has had in cable laying, these new cables can be manufactured and laid by England in a very short time, and there can be little doubt but that this extension of British cables, if not along the exact line above specified, yet with slight variations, will be an accomplishment of the near future.

With this extension of imperial cables added to her already extensive state-owned land line system, England will have the most complete telegraphic system in existence, placing each of the following fortified and garrisoned coaling stations in direct connection each with any other station, viz.: Hongkong, Singapore, Trincomalee, Columbo, Aden, Cape Town, Simons Bay, St. Helena, Ascension, St. Lucia, Jamaica, Bermuda, Halifax, Esquimalt, King George's Sound, and Thursday Island. The following "defended ports" would likewise be connected, viz.: Durban, Karachi, Bombay, Madras, Calcutta, Rangoon, Adelaide, Melbourne, Hobart, Sydney, Newcastle, Brisbane, Townsville, Auckland, Wellington, Lyttletown, and Dunedin.

Since with the completion of the cable across the Pacific the last telegraphic gap will be completed around the earth; it will give the great advantage of duplicate routes, since from any point

there will be then two routes—one east and one west—to any other station.

Proposed Colonial Telegraph System for the United States.

The objects and benefits of intercolonial cable communications are well recognized. Since the events of the Spanish-American war the supreme importance of exclusively controlled communications, as a means of military and naval warfare, has been realized as never before. All the principal nations are studying this subject in its various aspects, and already a distinct cable policy is entering into the politics of the principal countries possessing colonies, and seeking for commercial, military, and naval supremacy. Having examined briefly the principles and present benefits of the British imperial telegraph systems, it is clear that the United States will be wise to recognize this important subject, and not delay in laying a system of submarine cables, under the exclusive control of the United States, which will not only place every part of our new possessions in direct communication with one another by the best means of intelligence transmission, but will complete the system by deep-sea cables, directly connecting these possessions to the mainland of the United States.

In this connection it may be of interest to note briefly what has been the telegraph policy, up to the present, in dealing with the territory of our new possessions. In Cuba and Puerto Rico, and in the Philippine Archipelago, every effort has been made by the Signal Corps of the army to cover the islands with a network of wires, so complete and reliable that intercommunication is insured at all times. In the pacification of Cuba and Puerto Rico, in the suppression of the Philippine uprising, it is believed that there has been no more potent agent than the military telegraph.

For years Spain had been trying to pacify the Island of Cuba and yet her telegraph system was incomplete, obsolete, and unreliable in the extreme. It was possible for bands of insurgents to move about much at their pleasure, appearing here and there, with no means of locating or concentrating for their destruction. It was not that the number of troops was not sufficient, so much as it was that there were no efficient means of directing the troops in such a way as to make results decisive.

Philippine Military Telegraph System.

During the Philippine war the utility of the military telegraph has been most forcibly illustrated.

It has been assumed, as a principle from the outset, that the quickest means of pacifying and civilizing the Philippine Archipelago is to cover it with a network of telegraph wires. A given district, with adequate telegraph communications, can be guarded with less than half the troops than when such communications are wanting. Commanding officers can crush an incipient uprising suddenly, and before it has time to assume dangerous proportions, by concentrating, by telegraph, the garrisons from all directions upon the one point involved. Already there are about 2500 miles of land telegraph lines in operation in the Philippines, and about 260 miles of inter-island and lake cables have been laid, while a cable-ship transport, carrying four hundred miles of additional deep-sea cable, will leave New York for the Philippines within the next two months. At the last report, the telegraphic messages in the Island of Luzon alone exceeded 6500 per day, averaging over 40 words each, or approximately 260,000 words daily. As an illustration of the absolute necessity of telegraphic and cable communications in the work in the Philippines, it may be added that the telegraph is practically the only mail service that exists, and that recently while the English cable from Manila to Iloilo was interrupted by earthquakes for a period of six weeks, it was impossible to communicate with the southern islands. About three weeks ago a battle was fought at Cagayan, in the island of Mindanao, in which 150 American soldiers met with one of the heaviest resistances yet experienced in the Philippines. Owing to the lack of telegraphic communications, and lack of boat transportation, nothing was known as to the fate of these men for over two weeks.

A comprehensive and progressive scheme of land lines and inter-island cables, embracing the entire Philippine Archipelago, is rapidly being constructed. Already the Department of Northern Luzon is well covered with lines, reaching from Manila to the northern extremity of the Island.

Two trunk lines have been established—one along the west coast, the other along the Rio Grande de Cagayan river. The islands of Cebu and Loite have been connected by cable, and a

complete new route from Manila to Iloilo will soon be in operation, furnishing a duplicate route to the present English cable direct from Manila to Iloilo. In the Department of Mindanao and Jolo, the plan involves direct communication, by cable, between the principal islands, and by land lines and cable to the telegraph system in the Department of the Visayas, and from thence by duplicate routes to Manila.

The Alaska Telegraph System.

The growing commercial importance of Alaska, and the prospective future of that country, as indicated by the best experts, has made the construction of a telegraph system for this territory an imperative necessity. The recent creation of the new military Department of Alaska, with headquarters at St. Michael, on Norton Sound, and the establishment of military garrisons along the Yukon to the Canadian border, has made such a line a commercial and military necessity.

Congress recently authorized an expenditure of $450,000 for the construction of such a line, and at this moment all the material for the construction and equipment of this system is under contract, and the work of manufacture is being pushed night and day.

Owing to the shortness of the working season in this latitude, and the very unusual conditions under which the line must be constructed, as well as the lack of any adequate transportation, it will probably not be possible to complete the line this season.

The military cable connecting the gold district of Cape Nome with the headquarters at St. Michael, and also connecting St. Michael with Unalaklik, which is to be the terminus of the land line up the Yukon, will be completed early in September next, and will place the department commander at St. Michael in direct communication with Cape Nome.

These submarine cables, as well as all cables for the Philippine Islands, involving in the aggregate nearly 800 miles, are being constructed by American manufacturers, and are to be laid, equipped, and operated by American engineers.

The military forts to be connected, with the approximate distances, are shown in the following table:

	Valdez.	Fort Egbert.	Circle City.	Fort Yukon.	Rampart.	Fort Gibbon.	St. Michael.
Fort Egbert.....	350	....	....	....	....	....	....
Circle City.....	520	170	....	....	....	....	....
Fort Yukon.....	610	260	90	....	....	....	....
Rampart.....	870	520	350	260	....	....	....
Fort Gibbon	940	590	420	330	70	....	....
St. Michael	1,490	1,140	970	880	620	550	....
Cape Nome	1,610	1,260	1,090	1,000	740	670	120

By a recent temporary arrangement with the Canadian authorities this telegraph system will be enabled to reach the United States over the line now being constructed by the Canadian government between Atlin and Quesnolle, a distance of about 900 miles. It is doubtful, however, if this land line can be completed this season. When completed, and in connection with the Alaskan system outlined above, there will be direct telegraphic communication between the United States and the military department of Alaska at St. Michael.

Inter-Island Communication for the Hawaiian Group.

There is no other example in the world of a highly civilized community, with a republican form of government, which is entirely cut off from all communication from the rest of the world, except the Hawaiian Islands. A system of communication between the principal islands, either by submarine cable or by wireless telegraph method, is a necessity, and it is reported that this work, by the use of wireless telegraphy, is about to be carried out. The principal islands of the Hawaiian group which should be connected, with the approximate distances involved, are given in the following table:

	Distance, Naut. Miles.
Kauai to Oahu	61
Oahu to Molokai	23
Molokai to Maui	8
Maui to Hawaii	26
Total	118

Telegraph System in Cuba and Puerto Rico.

The land telegraph system of Cuba now aggregates about 2500 miles and includes a central trunk line the entire length of

the island, which is duplicated from Havana to Sancti Spiritus. In addition to this trunk line there are no less than thirteen lines across the island, which divide the island up into comparatively small sections. Although these lines have had to be entirely reconstructed under great difficulties, yet their reliability is evidenced by the fact that the entire Puerto Rican government business, which is now transmitted over the new land lines from Havana to Santiago, was conducted during the month of June without a single interruption.

In the island of Puerto Rico every important commercial or military point is in telegraph connection by a system of lines, which, under Major W. A. Glassford, Signal Corps, has been entirely reconstructed and routes improved since the disastrous hurricane of 1899.

A Pacific Cable.

In order to bind together the local land telegraph systems, which have been outlined above, these systems should be directly connected at an early date with the United States. First of all, in this colonial system, is the proposed trans-Pacific cable, connecting California with the Hawaiian Islands, thence to Midway Island, thence to the Island of Guam, and from thence to the Island of Luzon. The project of a trans-Pacific cable has been much discussed recently, and President McKinley sounded the key-note for its construction in his message to Congress in February, 1899, in which he states that "Such communication should be established in such a way as to be wholly under the control of the United States, whether in time of peace or of war." The construction of such a cable has been shown to be entirely practicable, and American manufacturers have shown themselves willing to undertake and guarantee the manufacture, laying, equipment, and operation of such a system of trans-Pacific cables.

Although deep-sea cable manufacture is an interest little known by experience in this country, yet it is believed that American capital and American skill and ingenuity, supplemented, if necessary, from abroad, can accomplish this great work in a comparatively short time. From every standpoint—commercial, strategic, and political—a trans-Pacific cable along the route mentioned should be undertaken at the earliest possible date. Next to the Isthmian Canal, no other great public work com-

pares with it in importance to the future development of the United States.

The telegraph system of Alaska, now authorized and under construction, should also be connected to the United States by lines touching only American territory, and exclusively under American control. A cable system from Vancouver via the Aleutian Islands to Japan and the Philippines has long been proposed, and has many points, commercial and technical, in its favor as a trans-Pacific route. The true solution is thought to be the early construction of both of these trans-Pacific cable lines, thereby furnishing, first, a direct connection to the United States' Alaskan system, and by a later extension to the Philippines, a duplicate route for the protection of the more southern line via Hawaii, which should be first constructed. A short cable from Sitka to Valdez would be one means of perfecting a junction with the Alaska land system.

The recent acquisition by the United States of the Island of Tutuila, and the construction in Pango Pango harbor of a coaling station, makes it desirable to join this advanced American station in the southwestern Pacific to the Hawaiian Islands by submarine cable.

This can probably be most readily accomplished by connecting it directly to Fiji, a station on the British Pacific cable route.

To further complete this proposed colonial telegraph system, it will be necessary to connect the Island of Puerto Rico, by submarine cable, to the United States, and although of greater length, a line direct from New York to Puerto Rico is suggested as offering many advantages. The shortest line is not always the most advantageous. For instance, Hayti is connected direct to New York City, instead of to the coast of Florida, which would be much shorter, and Bermuda is connected direct with Halifax for the sole object of exclusive British control under all circumstances.

ESTIMATED COST OF PROPOSED COLONIAL TELEGRAPH SYSTEM.

CABLES IN THE PACIFIC.

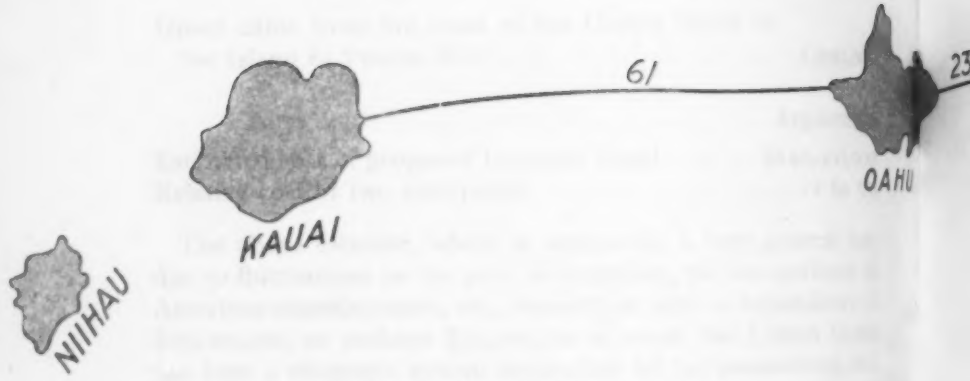
Trans-Pacific cable, San Francisco, via Hawaiian Islands, Midway Island, and Island of Guam to Luzon	$12,000,000
Inter-Island communication for the Hawaiian Group.	150,000

To complete the Inter-Island telegraph system of the Philippines	250,000
For Alaska telegraph system, as already authorized by Congress	450,000
To extend the Alaska telegraph system, and to connect it to the United States by direct cable, and also for further extension to the Philippines, via the Aleutian Islands, providing a duplicate trans-Pacific route to the Philippines	10,000,000
For cable connections with Tutuila Island coaling station at Pango Pango harbor	650,000
CABLES IN THE ATLANTIC.	
Direct cable from the coast of the United States to the Island of Puerto Rico	1,500,000
Total	$25,000,000
Estimated cost of proposed Isthmian Canal	$140,000,000
Relative cost of two enterprises	1 to 5.6

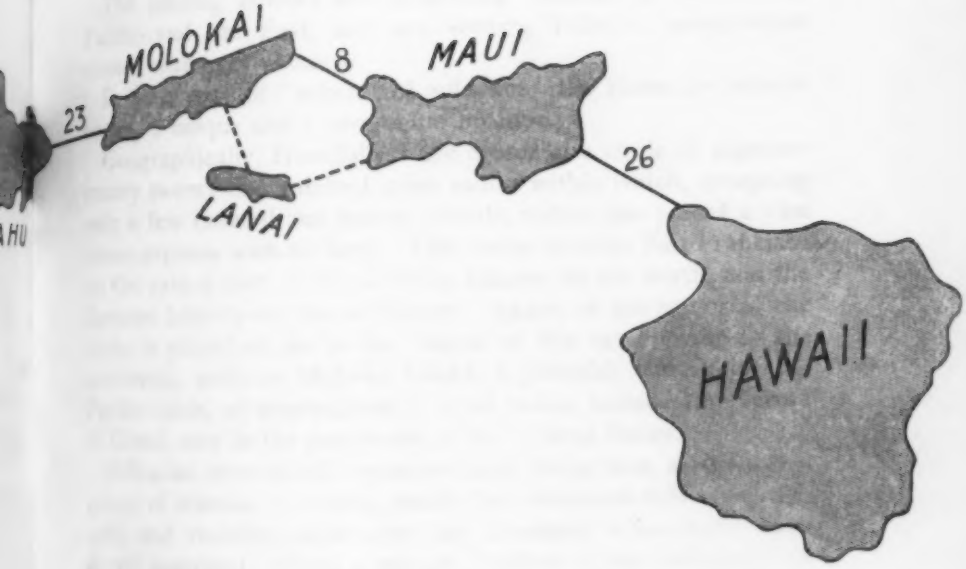
The above estimate, which is necessarily a very general one, due to fluctuations in the price of materials, the inexperience of American manufacturers, etc., shows that with an expenditure of $25,000,000, or perhaps $30,000,000 at most, the United States can have a telegraph system connecting all her possessions, and placing each part of such possessions in direct connection with the United States by the best and most efficient means of communication known.

For the expense of three or four first-class battleships the United States can provide herself with the most powerful means known for extending and preserving her commercial influence, for the speedy pacification and civilization of the people who have recently come under her control, and secure a strategic advantage—military, naval, and political—which is necessary to the position of the United States as a world power.

It is believed that there is no measure which should receive more immediate and careful consideration than the establishment of a system of deep-sea cables, wholly under the control of the United States, and joining the already extensive land telegraph system of our new possessions.



PROPOSED INTER-ISLAND
COMMUNICATION
FOR HAWAIIAN ISLANDS.


MOLOKAI
8
MAUI
23
26
LANAI
HAWAII

MAUI
MOLOKAI
LANAI
HAWAII

American commerce, American diplomacy, and American military and naval prestige, all conspire in demanding this system at the earliest possible date.

The Strategic Value of the Pacific Cable.

The control of the seas along the great natural lines of national commerce is chief among the material elements which contribute to the power and prosperity of nations.

The possession of the Hawaiian Islands by the United States has a far greater future importance than mere import and export statistics can ever indicate.

The leading powers are evidencing unusual interest in the Pacific and the East, and are seeking hitherto unimportant islands wherever situated.

In these days of "spheres of influence" the Hawaiian Islands occupy a unique and a paramount position.

Geographically, Honolulu is the center of a circle of approximately twenty-one hundred miles radius within which, excepting only a few isolated and barren islands, nature has placed a vast ocean expanse with no land. This circle includes San Francisco on the east, a part of the Aleutian Islands on the north, and the Samoan Islands on the southwest. Again, of the center of the circle is placed at one of the islands of this same group to the northwest, such as Midway Island, a probable station for the Pacific cable, an approximately equal radius includes the Island of Guam, now in the possession of the United States.

Hawaiian inter-island communication being now assured, this group of islands, extending nearly two thousand miles in longitude, and standing alone over two thousand miles from continental mainland, defines a natural "sphere of sea influence" in the North Pacific of incalculable value to the future of the United States.

The importance of the geographical position of this group is only properly determined by reference to the changes in the great trade routes which will result from the Isthmian Canal. Whether ultimately at Nicaragua or Panama, the immense merchant fleet, which will pass through this gateway, will find the Hawaiian group upon its direct course to the East, and at such steaming distance as to naturally require this as a mid-ocean stopping place. Again, the British-Canadian commercial route

to Australasia along which the British Pacific cable is projected, as well as the direct mail and trade route from the Pacific States to the Philippine Islands and the East, both naturally pass through these islands.

It can be stated that there is scarcely any point in the world where there is greater need for a central cable station than in the Hawaiian Islands. Geographically situated at the military and commercial strategic position of the North Pacific Ocean, it will ultimately serve as the distributing center for ocean communication between the two hemispheres as well as to the various island groups of the Pacific.

Although it is said that cables are primarily established for peace rather than for short periods of war, yet in these advanced American outposts, extending in a chain to the Philippines in the East, the demands of both peace and war happily coincide.

Submarine cables are now established for colonial, political, and diplomatic reasons, as really as for their purely commercial purposes. Nor is actual state of war of the country itself the only fear; witness the present plight of France due to the Transvaal war; owing to the fact that the cables to South Africa are under the control of England, and the establishment by her of a war censorship, France is absolutely dependent upon England not only for news from the Transvaal, but also for communication with her own colony of Madagascar and her South Africa possessions. The importance of this subject has led her Colonial Commission to recommend recently the immediate construction of submarine cables joining France with Senegal, Madagascar and Tonkin, the latter connecting with the Danish company's cables. Indeed, the plan ultimately involves an estimated expenditure of twenty-five million dollars and includes a complete colonial cable system.

By whatever method the first Pacific cable is ultimately laid, and provided that it shall appear that all of the present projected cable cannot be manufactured and laid in the United States within a reasonable time, it seems plain that the encouragement of American manufacturers in the building up in the United States of a deep-sea cable industry of the first class, is a wise policy for this government.

The successful completion of the submarine cable across the Pacific will mark an epoch in the telegraph history of the world.

After thirty years of consideration—technical, commercial and political—the end of the century sees this great enterprise at last seriously undertaken. The full influence which it will exert upon the Western Hemisphere and the world in general is not easily appreciated. Strategically the importance of the inter-colonial communication and its preservation are very great; however, the Philippine question should not overshadow the larger question—the Eastern question—in the consideration of this project. Important as the cable will be as a means of joining the Philippine Archipelago to the United States, its larger importance will ultimately be in the future commercial development between the United States and the far East. In the broad extension of Pacific trade consequent upon the completion of the Isthmian Canal, and the development of steamship lines plying the Pacific, the telegraph cable would naturally become an important factor. The present trans-Pacific steamship lines are heavily handicapped by absence of direct means of telegraphy between the ports between which they operate. Situated on the main trade routes leading from the canal to Asiatic ports, the Pacific cable will serve as a powerful adjunct and support to this enterprise. The two go hand in hand and are mutually closely related.

The Military Control of Telegraph Cables in Time of War.

The International Convention for the protection of submarine cables, which met at Paris in 1884, made no provision defining the rights and immunities of cable property in time of war.

In addition to incorporating an article in the convention, stipulating that "this convention shall in nowise affect the liberty of belligerents," Lord Lyons, the British delegate, submitted the following declaration, at the moment of signing the convention: "Her Majesty's government understands Article XV in this sense, that in time of war, a belligerent, a signatory of the convention, shall be free to act in regard to submarine cables as if the convention did not exist."

M. Leopold Orban, in the name of the Belgian government, also submitted the following declaration:

"The Belgian government, through its delegates to the conference, has maintained that the convention has no effect upon

the rights of belligerent powers; These rights would be neither more or less extensive after the signature than they are now. The mention inserted in Article XV, although absolutely useless in the opinion of the Belgian government, would not, however, justify a refusal on its part to unite in a work the expediency of which is indisputable."

Before the Spanish-American war there were few examples of damages done to submarine cables by belligerents.

As has been pointed out, Article XV of the Convention of Paris, of 1884, for the protection of submarine cables, subscribed to by twenty-six nations, specifically states that "The stipulations of this convention shall in no wise affect the liberty of belligerents." In consequence, the question as to what, if any, special protection was to be accorded submarine cables in time of war, remained theoretical until the Spanish-American war of 1898, when a practical rule of action as outlined by General A. W. Greely, Chief Signal Officer of the U. S. Army.

Upon the declaration of war, General Greely, upon whom by law devolved the operation of military telegraph lines and cables, was called into the national council for his opinion as to the line of action best calculated to subserve the legitimate rights of commerce and industry, while conserving the military interests of the United States. He took the view that, inasmuch as postal communications were forbidden between belligerents, prohibitive orders should issue against such telegraphic correspondence as might benefit the public enemy, pointing out that telegrams, by their secrecy and rapidity, produce military results much more important and injurious than is possible by the use of the mail.

First of all standing for a liberal policy consistent with our advanced civilization, it was advised that cable operations should continue over the international cables between Havana and Florida, of course, under strict military censorship. Military possession of the Key West telegraph office was taken on April 23, 1898, and the cables cut so that Jacksonville could no longer work with Havana. Domestic and business messages in open text were allowed to be sent and received from Havana, but only under strict military censorship. Similar action was taken at Havana by the Governor-General of Cuba, who established a rigid Spanish military censorship, so that all messages were subject to double scrutiny.

Five classes of cables were recognized:

First. Those of which the termini are in the enemy's country; for instance, the Cuba Submarine Cable system along the south coast of Cuba.

Second. Which directly connect countries at war, so that each belligerent controls one end of cable; for instance, the International Oceanic Telegraph Company between Florida and Havana.

Third. Where one end of the cable is in the enemy's country and the other in neutral territory; for instance, the West India and Panama cables extending from Jamaica to Cuba, and to Puerto Rico, and thence to Saint Thomas.

Fourth. Where a cable extends from the coast of an offensive belligerent to a neutral country contiguous to the territory of the defensive belligerent; for instance, the Hayti cable from New York City to Hayti, where there is direct cable connection with the Island of Cuba.

Fifth. Other cables having one terminus in the territory of the offensive belligerent and the other in neutral regions remote from the scene of hostility; for instance, the Atlantic cables connecting the United States with Europe.

To cables of the first class, whether the property of the defending enemy or a neutral corporation, was applied the simple and well-known rule that they are subject to the vicissitudes of war, and that being in use for war purposes they are proper objects of offensive military operations. The orders issued to the officers of the Signal Corps looked upon these cables, whether they were laid in the high sea or along the immediate coast, as liable to seizure and total destruction.

Cables of the second class were easily dealt with, the cables between Key West and Havana were taken possession of militarily by Spain in Cuba and by the American army in Key West. Messages going and coming were subjected to the most rigid military censorship at both ends of the cable. Only messages in plain text bearing upon business and social subjects were permitted, and where any suspicion existed as to the loyalty of the sender, were either refused or not sent. Exceptional cipher messages were permitted as a matter of courtesy and favor to selected diplomatic representatives of neutral nations.

The cables of the third class were viewed as contraband of

war; but it was also recognized that their liability to destruction depended in a measure on the locality of the cable. It was recognized as unsettled and of doubtful expediency, the right of any belligerent to raise from the bottom and destroy on the high sea a neutral cable, merely on the ground that such cable landed in a hostile country. A more rigid rule was applied, however, to such portions of cables, cable huts, instruments, etc., as were located within the territorial jurisdiction of the enemy. Orders were given, based on the principle that such cable properties, whether belonging to an enemy or to neutral corporations, are not only subject to the vicissitudes of war, but, being contraband of war, are legitimate objects of military operations.

In accordance with this view orders were issued to cut, off the south coast of Cuba, any cables that could be grappled and picked up, either within a marine league of the coast or within range of Spanish batteries.

In Cuba and Puerto Rico, during the Spanish-American war, certain neutral cable stations of this class fell within the power of the army of the United States. In such cases the officials of the neutral cable companies were given a choice of action. They could abandon their property to the vicissitudes of war, or accepting the *force-majoure*, were allowed to transact business under strict military censorship. Even during the siege of Santiago the orders permitted the French Telegraphic Cable Company to accept business for Santiago-de-Cuba within the Spanish lines, every such message, however, to be vised by the military censor.

The fourth class of cables was seized by the military forces of the United States and operated under strict military censorship. Code and cipher messages were absolutely refused save for the authorized government agents and certain excepted diplomatic representatives, the latter as a matter of courtesy.

Cables of the fifth class were placed under a military censorship. Of these, there were five systems comprising eleven separate cables. Most of these telegraph cables were only constructively seized, intrusting the direct censorship of messages, under the general supervision of an officer of the Signal Corps, to the respective superintendents, men of high character, whose good faith was guaranteed by the companies whose interests they likewise guarded. The interests of the United States were thus

subserved while the privacy of the affairs of the companies was conserved. The responsible officials gave a written pledge to observe such rules as might be filed by the Chief Signal Officer with the companies. These rules prohibited all messages to and from Spain, and also certain other classes which were deemed prejudicial to the military interests of the United States. In cases of doubt messages of the latter character were examined and vised by the military censor.

The events of the Spanish-American war brought to attention the whole subject of the legal rights of cable property, and the control of the same under varying and complex conditions, in time of war. In the absence of definite international law upon the many points involved, the United States was forced to take the initiative and use this powerful military weapon for the benefit of the cause of the United States, while at the same time respecting and subserving the rights of neutrals with an equity and fairness, which has always characterized the actions of this government.

In the West Indies, as well as in the Philippines, the cable question was always a paramount one, and the United States finds herself now confronted with legal questions, growing out of actions necessary in time of war. Since submarine cables have become such a dominant influence in time of war, and since the cases which may naturally arise are often complex and involved, it is clear that a further international cable conference is a necessity of the near future, in which a more definite international understanding of methods of procedure in time of war may be agreed to. This international conference could properly consider other international cable matters, which the great advance in submarine telegraphy has made important. Among those may be mentioned the construction and authorization of a uniform international cable code for economical and efficient communication between different parts of the world in any of the principal languages now authorized by the international telegraph rules. Since next year will be the 50th anniversary of the first successful submarine cable, this would perhaps be a fitting time for the calling of such an international cable convention.

The Cable Equipment of a Fleet.

It seems clear from the history of the Spanish-American war that provisions must be made for laying, picking up, cutting,

and operating submarine cables in time of war. From the outbreak of this war every attention was given to the problem of isolating the Island of Cuba from Spain.

The special fitting out of the Adria with cable appliances, as well as spare cable, the work of the St. Louis in cutting cables, the operations of the Marblehead, Nashville, and Windom at Cienfuegos, and of the Wampatuck, are too well known to be repeated here. It will be more valuable to endeavor to draw the correct conclusion from these operations, and thereby make proper provision for the execution of similar operations in time of war.

It appears that the searching for deep-sea cables in the high seas in time of war, without an accurate chart of the location of the cables, is a difficult and very doubtful operation; also that submarine cables must in general be interrupted near their landing places, where their exact location can be determined with certainty. From the experience of the Spanish-American war, operations of this kind are extremely dangerous, as the cable landing will be protected and defended by the enemy.

Supply of spare cable and suitable instruments for working the same, must be available, with every naval fleet; in order to supply the necessary communications with the shore, in case of the landing of either a co-operating army, or of temporary forces from the ships. Cableships engaged in either laying, cutting, or repairing cable near the shore, must either be provided with their own means of defense, or else convoyed by warships.

The above facts make it clear that a new type of naval ship is to make its appearance as a necessary adjunct to every naval fleet. Just as the naval repair ship, such as the Vulcan, has been found necessary, so will the new cable cruiser be an essential part of the navy of the near future. It is not intended here to enter into the question of the proper design of such ships best adapted for the purpose, but it would seem that a specially designed cableship with comparatively large coal capacity and high speed, and an armament of the lighter cruiser class, making her capable of defending herself and protecting her small boat parties, would be general conditions for the naval cableship of the future. She must carry a moderate supply of spare cable and machinery for laying and picking up cable, as well as instruments for testing and operating a cable, and the necessary buoys

suitable, if necessary, for buoying the cable and operating the ship as a floating cable station. It is unnecessary to state that her personnel must be specially trained in the highly technical duties required, and from actual practice in all the operations necessary, be made ready for the performance of their duties efficiently under the conditions of war.

Although these naval cable cruisers in time of peace could be profitably employed in maintaining and repairing both cables belonging exclusively to the government and those subsidized by the government, under suitable arrangements, yet, at the outbreak of war, they should be absolutely and exclusively under the control of the government. It may be said at present that no modern fleet is complete without a cableship especially adapted for cable operations in time of war.

In addition to special cable-ships it is desirable and necessary that every warship should be provided with certain simple cable appliances for raising and cutting cables, and should have at least one person aboard familiar with the practical and technical side of cable operations.

Since submarine cables are so important a factor in national defense, they should be protected both at their shore landings and on the high seas by military and naval force.

In this connection it would seem advisable in case of government cables, or in cables subsidized by the government, to keep the exact route of important cables a secret, and prevent the publication of maps for general distribution, showing the exact location of cables in the deep sea. The location of the shore ends, however, are certain to be known, and probably will be the points where the cable must be picked up and interrupted. This forces, therefore, adequate land and naval protection for the landing places of all important strategic cables.

A cable landing of the future should partake of the character of a fort, and be provided with ample and adequate means for preventing an enemy locating and destroying the cable, within the marine league, or indeed, until it has reached deep-sea, where its accurate location is not known.

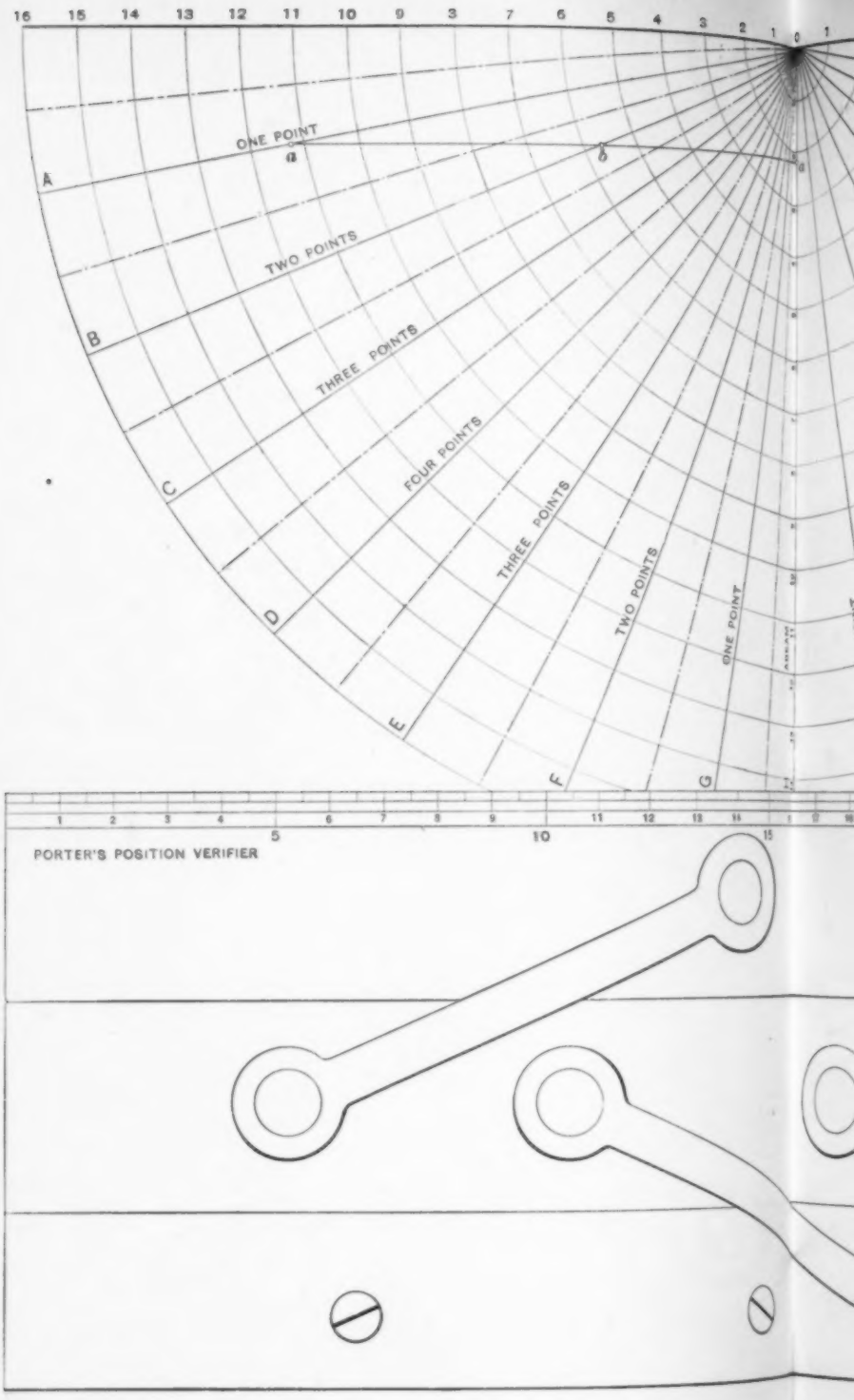
The sea is usually considered as the great international highway, belonging equally to all nations; this, however, is no longer true. The real political boundaries of states are no longer defined and restricted by the land, but involve such portions of the

high seas as a nation can, by her commercial and naval vessels, and her submarine cables, reach out and secure. In this great sea division, which is so surely taking place, probably there are no better guides to boundaries than the submarine cable networks, which lie in its great depths. Since each, in general, uses the shortest path between two points, the general commercial sailing lines of the world are also the general direction of submarine cable lines.

The United States will be wise if, in the great Pacific, where she has such paramount natural advantages, both for commerce and for maritime strength, she pursues a broad, vigorous, and even lavish, "cable policy." We should be able at the earliest date to manufacture upon American soil deep-sea cables of the first class; be able to lay, maintain and repair them in time of peace or war, by ships flying the American flag, and be prepared to adequately protect them upon the high seas, and at their landing places, by military and naval force.

The cable question is one of the most important of the present hour, unique in that American commerce, diplomacy, and sea-power—in fact the most efficient means of advancing and securing the benefits of civilization itself—happily conspire in demanding its early solution.

[See maps at end of number.]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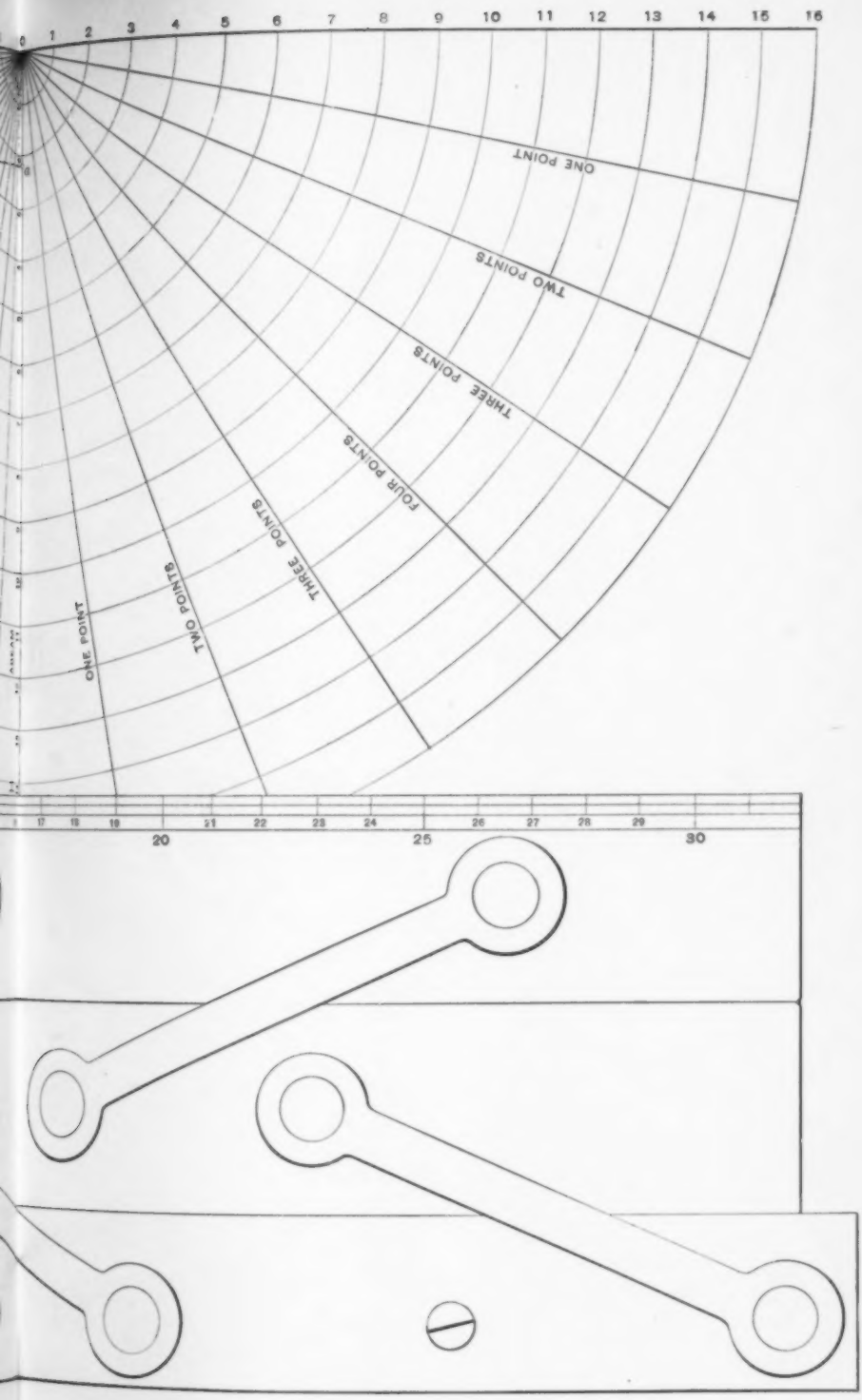
PORTER'S POSITION VERIFIER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25
30

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PORTER'S POSITION VERIFIER—AN AID TO SAFE COAST NAVIGATION.

By Captain Allan H. Porter.

The instrument consists of a plane surface to which near the bottom is screwed the lowest of a system of triple parallel rules, the upper two having motion parallel to the horizontal diameter of the concentric semicircles drawn on the plane surface, and to which diameter the ship's course is supposed to be parallel. The upper edge of the uppermost rule and the horizontal diameter are graduated in the same scale of miles and parts.

The center of the concentric semicircles represents the objects upon which bearings are taken, and the semicircles are spaced one mile apart.

Radii are drawn at convenient angles from the horizontal diameter; in the sketch at the points and half-points.

The triple rules give facility and flexibility of motion, so that the distance run can be at once fitted between the appropriate radii.

The following example shows the use:

A lighthouse on the coast is observed to bear one point on the port bow. The ship holds her course and runs six miles, when the lighthouse bears two points on the port bow.

Move the parallel rules till the distance six miles on the upper rule is intercepted exactly between the one and two points radii, *AO* and *BO*. Then *a* and *b* represent the positions of the ship with respect to *O*, the lighthouse, at the times of observation. The ship was distant from the lighthouse 11.3 miles at the time of the first observation and is 5.7 miles away at the second; if she holds her course, she will pass the light abeam at a distance of

2.2 miles. The result can be verified by observing the distance run between the different lines of bearing and the ship's position assured before she is abreast of the object observed, which is of the utmost consequence when there are outlying shoals.

This instrument supplies an automatic substitute for Tables 5A and 5B of Bowditch, and instantly and graphically solves all problems coming thereunder.

Its simplicity and usefulness commend it to all who see it.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A STRETCHER FOR WOUNDED ON BOARD SHIP.

By LIEUT.-COMMANDER DENNIS H. MAHAN, U. S. Navy.

The stretcher consists of a board 6.5 feet long, 18 inches wide and 1¼ inches thick, with fittings as follows: Six rope handles, three on a side, for carrying purposes; a rope strap at each end for use with a whip or hook-rope when desiring either to lower down a hatchway or ease down a ladder; three canvas bands, one to pass across the breast, one across the abdomen, and one across the legs; and on the back two runners 1½ inches deep, useful when sliding down ladders. As experiment showed that the patient would slip, a buttock piece was inserted and with this and the abdomen strap the patient was absolutely secure and very comfortable.

The piece at the foot is merely a preventor, as the patient's feet should not touch it.

With a carpenter and a good seaman this stretcher can be made at any time on board ship; the cost being about one dollar.

During the spring of 1899 this stretcher was in use on the Brooklyn and also on other ships of the North Atlantic Squadron, and it was used during the Spanish war with great success.

DIMENSIONS.

(a) Stretcher bed,	length	6 feet 6 inches.
	breadth	1 foot 6 inches.
	thickness	1¼ inches.
(b) Buttock piece,	width of bed	
	height	3 inches.
	thickness	3 inches.
(c) Foot piece,	width of bed	
	height	3 inches.
	thickness	2 inches.

(d) Handles of rope.
(e) Straps fitted with thimbles.
(f) Chest bands, canvas, 3 inches wide.
(g) Abdomen bands, canvas, 4 inches wide.
(h) Leg bands, canvas, 3 inches wide.

	Rear View.	
(*r*) Runners,	length of bed	
	thickness	¾ inches.
	depth	1½ inches.
(*s*) Strengthening pieces,	length	16⅝ inches.
	width	5 inches.
	thickness	¾ inches.

The following extract is taken from a report of a Board of Surgeons:

"The stretcher was fully tested by us, men of different heights having been secured on it, and

"(*a*) Lowered in an upright position, feet first, from the main to the berth deck, and

"(*b*) Brought back to the main deck in the same position.

"(*c*) After this the stretcher was turned in every way, with the man's head down, on the side, etc., and no slipping was noticed.

"The essential and original point of the stretcher is the cross-piece near the middle which comes just below the buttocks, and when the strap above is buckled, a man is held in a remarkably secure and comfortable position. The other bands, one passing around the arms and chest and the second around the legs are ordinary additional methods for adding to the security of retention.

"This stretcher is well adapted to all the ordinary purposes of transporting the wounded and is especially adapted for use on modern ships, where hatches are small and not in the same line. If necessary it can be slid down ladders, or swung over the ship's side, with the wounded immovably and comfortably fixed.

"It can readily be made on board ship (if necessary) at a small cost. One has been in use on the U. S. S. Brooklyn for a year and has proved satisfactory in every particular. Another has been in use the same length of time on the U. S. S. Texas and is highly thought of by her medical officer. Other ships have it in use but we have no data from them.

"We recommend that the attention of the Surgeon-General be called to this stretcher and that it be adopted for use in all ships of the navy."

Medical Inspector C. U. Gravatt, U. S. N., Fleet Surgeon of the North Atlantic Squadron, referred to this stretcher thus:

"Lieut-Commander Mahan designed a stretcher which possesses the valuable essential qualities of simplicity, ease of con-

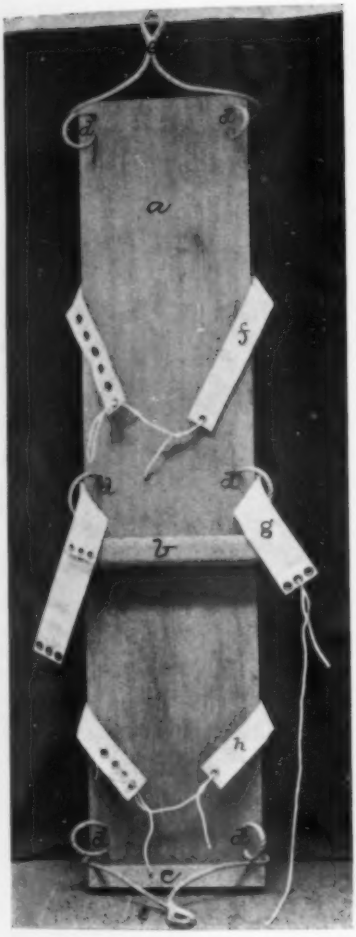

FIG. 1.

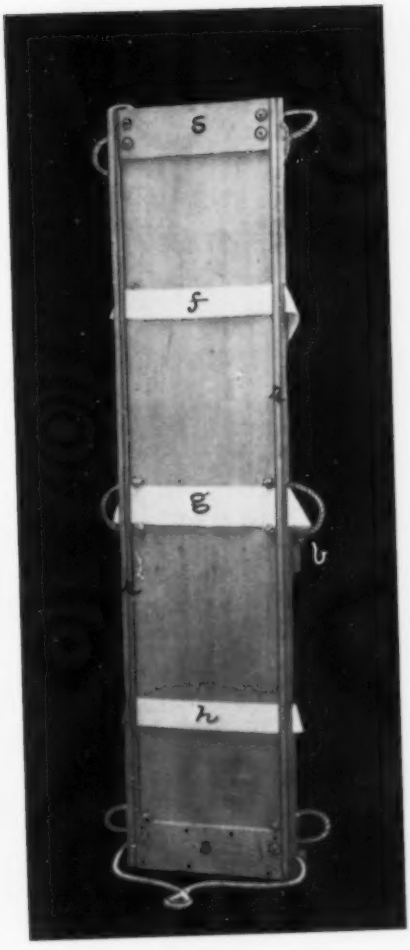

FIG. 2.

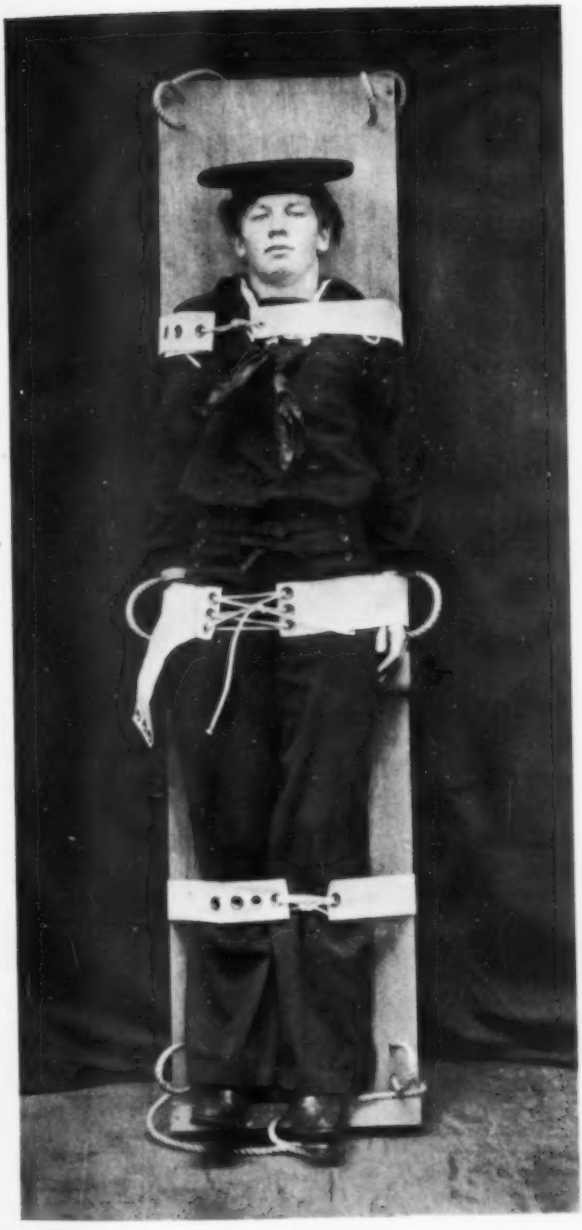

FIG. 3.

struction and efficiency, and which seems to surpass all others up to this time. As little more space is occupied than by a man's body, it can be readily accommodated in small boats. It was first thought the device could not be used for fractured thighs but in a severe case of this character it was most satisfactorily employed on the flagship New York last winter, and made transportation easy, which without it would have been difficult indeed. The writer was so well pleased with it on this occasion and others that during his service as fleet surgeon of the North Atlantic Station he advised its use on all the ships of the squadron, and, believing in its superior advantages, would be glad to see it adopted for general use in the navy."

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

TORPEDO SAFETY DEVICES.

By EMIL GATHMANN, Ordnance Engineer.

Various writers of note have spoken disparagingly of the use of above-water torpedo on cruisers and the larger ships in general, considering them a greater danger to vessels carrying them than to her opponent.

Wet guncotton, which constitutes the charge for warheads of all modern torpedoes, is admittedly the safest of all known explosives (far safer than powder), for it cannot even be set on fire while wet. Projectiles of large caliber have repeatedly been fired into masses of wet guncotton (I have personally made and also witnessed many tests of this kind), without exploding or even igniting any of the latter.

It is not, then, the fear of any danger inherent to the main charge of explosive in torpedo that has led to outspoken statements of commanding officers, and in some instances to request to have above-water torpedo tubes removed from vessels under their command.

It must be admitted that the danger referred to and feared lies principally in the very sensitive nature of the primer and detonator necessarily employed in connection with a large mass of wet guncotton. The air-flask, or chamber, of torpedo charged to hundreds of pounds pressure per square inch with compressed air constitutes the remaining element of danger to the users of torpedoes.

The impact of even very small caliber projectiles with either detonator or air-flask of torpedo as now constructed would most likely cause detonation of main charge of wet guncotton in warhead and consequent disaster to ships carrying torpedoes.

The invention and development of the submerged tube and the tendency to its use, is proof of the realization by various nations of the real danger of above-water discharge with the usual type of torpedo.

How to at least greatly modify, in fact, to practically obviate these dangers, it will be the object of my paper to briefly explain.

First, I would state that I am a firm believer in the above-water torpedo. Not only will its efficiency and reliability as a weapon always remain greater; but the very safety the submerged tubes are vaunted to give can be obtained by the above-water torpedo to a far greater extent, and that at a small percentage of the cost of the former. My "ideal" type of torpedo for coast defense and the heavier vessels is the true aerial torpedo or large caliber high-explosive shell; but I will not enter into any detail description or extollation of same in this article, as I wish to confine myself strictly to the water or fish torpedo.

It has long been well known (although personally the fact was rediscovered from original experiments) that very close contact between detonator, primer and wet guncotton charge are essential in order to detonate the latter. This being the case, it occurred to me that it would be of great value to determine at least approximately at what point with a given protection of metallic diaphragm or barrier, absolute immunity against transmission of detonation from primer to main wet charge of guncotton would be insured. With this object in view, I undertook an extensive series of experiments on the transmission of detonation in steel tubes, with and without interposing barriers, which were mainly conducted at both the army and navy proving grounds, through the courtesy of the departments.

My first tests were made with a number of steel tubes of 2¾ inches inside diameter, of about 2 feet length. One-half the length of tubes were loaded with 20 ounces of wet guncotton, containing 25 per cent moisture. Metallic diaphragms or barriers of varying thicknesses were inserted in tubes, and primers of ten ounces of dry guncotton and 38 grains of fulminate of mercury were placed in other half of the tubes, being separated from the wet charge by interposing metallic barriers. Detonation of primers was then obtained by means of electric firing of fulminate detonators, in which a platinum bridge wrapped with wisps of dry guncotton had been secured. In order to insure

recovery of fragments, and also to enable the determining of character of explosion, the loaded tubes were always placed in the proving ground shell explosion chambers. Some forty experiments of this character were made, with varying thicknesses of metallic barriers interposing between wet charges and primers. The same weight of wet charge containing 25 per cent of moisture and of primers and detonators were always employed. Three-eighths of an inch of mild steel as a barrier was found sufficient to effectually intercept the transmission of detonation. The greater part of tubes holding charges was invariably totally destroyed and broken up into many minute pieces, as were usually the interposing barriers. The wet compressed guncotton was always merely broken up and scattered about explosion chamber. Upon gathering up the wet guncotton, 97 to 99 per cent at least was always recovered, this being proof positive of the non-transmission of detonation when a suitable metallic barrier is interposed between priming and wet charge of guncotton.

It was also deemed of importance to learn to what extent detonation through the air, without interposing metallic barriers, could be carried, so as to be able to fully determine the value of said metallic barriers. Tests were accordingly made with similar steel tubes, only somewhat longer, with the barriers left out. An intervening air space of even as much as 14 inches failed to offer any protection. Detonation was repeatedly transmitted from primers of dry guncotton to the wet guncotton in tubes at this distance. In no instance were particles of guncotton found in explosion chamber, as had been the case when separating barriers were used.

The theory of protection offered by metallic separating barriers to transmission of detonation having thus been established, it remained to put the knowledge gained to some practical use. The safety fuse for high-explosive shell or aerial torpedoes, and the safety primer or detonator for fish torpedoes, the joint inventions of Mr. Louis Gathmann (my father) and of the writer, were the first practical uses to which these experiments have led. Numerous tests were then made with shells and torpedoes fitted with detonators having metallic barriers normally separating the main charge of wet guncotton from detonators and primers. Mechanical devices were invented and perfected which insured the interposition of barrier and isolation of detonator and primer

from main charge until torpedo had been launched from tube and traveled a predetermined distance. A number of bronze torpedo heads, holding 85 pounds of wet guncotton, 25 per cent moisture, were built to be used experimentally in connection with the separating barriers.

Two of these shells or torpedo heads, loaded with 81 and 86 pounds of wet guncotton respectively, and having primers of 12 ounces of dry guncotton and detonators of 38 grains of fulminate of mercury, separated from the main charge by steel barriers one inch thick, were set up in a firing butt as targets for Hotchkiss 6-pounder guns. The rapid-fire gun was trained so as to deliver its shot directly in center of detonator and primer, and in line with the longer axis of torpedo. Distance of gun from torpedo about 75 feet. On firing of gun two distinct reports were heard, and upon returning to the butt and examining torpedo, it was seen that impact had been as desired upon center of primer housing. The detonation of priming charge of 12 ounces of guncotton and consequent rupturing of torpedo casing was seen to have been the only result. As was expected, in view of experiments which had already been made, the main charge of wet guncotton had been protected by the interposing metallic barrier, and was simply somewhat scattered about by the detonation of primer and impact of six-pounder. This test was repeated in the presence of Commander Mason, U. S. N., several U. S. Senators and other gentlemen of note, with the second target shell. Practically identical results were obtained in this test, it having been proven thereby that positive safety is obtained by the interposing barrier under all conditions. A similar torpedo head, loaded with 79 pounds of wet guncotton, with the metallic barrier removed (as would be the case after being launched from the tube and traveling some distance from ship's side) and primer in contact with main charge, was then detonated by means of electric fuse. A conical excavation some ten feet deep and eighteen feet diameter showed violence and excellence of the detonation when primer was in position for action.

By the normal isolation and separation of detonator from main charge and the arrangement of mechanism to bring same into close contact when desired, the first or principal danger and consequent objection to the over-water torpedo has been removed. Lieut. G. E. Armstrong, late R. N., in "Torpedo and Torpedo

Vessels," quotes from Mr. Arnold Foster, "In a Conning Tower," how the enemy is made to lose the battle through the confusion caused on board of her by the explosion of one of her torpedoes in its tube before it is launched.

Such premature explosion I can state (without fear of contradiction) would be altogether impossible were the normally separated primer for torpedo employed. Any of our torpedoes can be fitted therewith at a very slight expense, as the same pistol and nose pieces as are now employed could be used, thus precluding any exhaustive tests for regulating of new devices, etc. Detailed drawings submitted show how I would recommend to have changes made on warheads of torpedoes. The arrangement for bringing primer in close contact with main charge is entirely automatic and can only work after the torpedo has left its tube and traveled a predetermined distance in water from side of ship. Having thus shown how the first or greatest danger of the overwater torpedo can be obviated, I would beg leave to proceed to the second, and, in my opinion, only slightly lesser danger which arises from the likelihood of rupture of air-flask or chamber of torpedo should the same be struck by an enemy's missile. These air-flasks are, from the very nature of their construction, exceedingly fragile and cannot very well be made otherwise. Some tests made at Newport in the immediate past have shown that on impact of even very small-caliber projectiles the air-flask will burst explosively. Such explosion, although not necessarily imperiling the ship carrying torpedo, would still produce considerable damage by virtue of energy of flying pieces of flask, and certainly create considerable confusion aboard ship on which it took place. The accidental explosion of air-flask due to the enemy's missile or to other unforeseen causes we will always be at a loss to control. I would merely show a method whereby the damage resulting from such explosion would be reduced to a minimum. The danger due to explosion of flasks is mainly attributable to the scattering of pieces of same and their consequent projection and damage to surrounding objects and the torpedo crew.

As the air-flask of torpedo would doubtless be always charged in action, even though the torpedo were not entered into tube, I would propose that the torpedo be kept in a sling or cage, composed of a number of strong steel rings or wire grommets held together by two or more longitudinal stiffening rods. The rings

or grommets should be spaced at intervals of, say, five or six inches, and particular care taken that portion of torpedo composed of air-flask or chamber is covered by same. Should the air-flask explode from any cause while in a sling of this description, the resulting damage could not be very great. The air in flask would simply press the shattered portions of shell against the series of rings or grommets, which would prevent said pieces from acquiring any velocity, and, consequently, from doing serious damage. The weight of such slings would not greatly exceed that of the usual cages in which torpedoes are housed aboard ships. The slings would not be such in name only, but would be used to transport the torpedo from its housing to its tube. After the torpedo has been entered into tube and sling is empty, it could be disassembled and knocked down, so as to occupy but a very small space, especially if wire grommets were used as suggested.

The torpedo-tubes should also be covered at short intervals with strong wire grommets for confining pieces in case of explosion of flask while torpedo is in tube. Such wire grommets would not add over two per cent to the weight of tubes and torpedoes and would undoubtedly confine most of the fragments in case of disaster to air-flasks. I would state that both the grommets for slings and on torpedo-tubes should not be tight fitting, but should have sufficient clearance so as to only take up the strain of fragments incident after actual rupture of air-flasks or torpedo-tubes. This arrangement will allow the compressed air large vents for escape, but will retain most all the fragments of ruptured torpedo-flask and tube.

Exactly what degree of protection will be provided by torpedo sling and tube grommets as I have described, it is as yet impossible to state. Experiments are, however, being made by the writer to determine the proportion of fragments which will be retained by wire grommet slings fitted over the body of an old 18-inch air-flask.

It follows that with the simple changes in construction of detonator and the easily installed sling, appliances, described, the usual above-water torpedo, which has hitherto been considered a grave menace to its users, can readily be transformed into a weapon which is capable of always being handled with perfect safety.

This being granted (for I challenge proof to the contrary), there are no valid reasons why the relatively simple above-water tube torpedo should not be preferred to the complex, costly submerged tubes and apparatus.

The positive knowledge of officers and crew of torpedo vessels that they have nothing to fear from the forces they put into action, but that they are merely subject to ordinary chances of battle, will, to say the least, tend much to their morale and steadiness and consequent efficiency of their weapon.

Safety of weapon to the user should be the first essential in all military appliances and armament.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

OPERATIONS IN NORTH CHINA.

By LIEUTENANT W. C. DAVIDSON, U. S. Navy.

Early in 1900, after the war in the Philippines had developed into a series of assassinations and guerrilla combats against our soldiers, the attention of the United States and the rest of the civilized world was called to a change of affairs in China which required foreign intervention for the protection of the lives and property of all classes of foreigners residing within the limits of the Chinese Empire.

An organization known as "Boxers" conceived the idea of exterminating all "foreign devils" in China and began operations by murdering the missionaries and other foreigners in the interior. The "Boxers" were originally an athletic society which, among other ceremonies, worshipped an immense sword or knife, and became known first, as the Great Sword Society, and later as the Society of the Avenging Sword. The Chinese characters have been variously translated to mean, not only the above, but also, the Righteous Arm Society, and this, by a still more liberal interpretation, was converted into the present name "Boxer." The organization has existed for nearly a hundred years, but until the introduction of railroads, foreign improvements, and the presence of missionaries in the interior of the country, it has given no trouble. With the presence and continued advance of foreigners, however, the ruling class of Chinese lost power over the common people, and consequently the Boxers are said to have been instigated by the Empress Dowager, together with some of the Princes and Viceroys, to exterminate all Europeans and Christian Chinese, thus hoping to return the country to its former state of exclusion and solitude.

In March, 1900, the situation began to look serious. The Boxers appeared in uniform in great numbers, armed with knives and spears, their distinguishing marks being red belts and red trimmings on their weapons. They first threatened the outlying missions along the line of the new railroad to Hankow, and later the Christian Chinese in and around Peking itself. The Chinese government took no notice of the movement and maintained that there was nothing to be feared from the Boxers, although evidence has since been found showing beyond all doubt the complicity of the Empress Dowager and others, and also showing that a general uprising had been planned to take place in September of this year.

The foreign ministers became alarmed, despite the protestations of the Chinese government, and in May asked for guards to protect the legations. Marines and bluejackets were sent up by the navies present at Taku until a force of about 600 armed foreigners were in Peking protecting lives and property. Early in June, the railroad communication between Tientsin and Peking was destroyed and actual hostilities began in the streets of the capital.

In the meantime a large fleet of war vessels of the various nations had assembled off Taku, and as soon as the news of hostilities was received, Vice-Admiral Seymour, R. N., with an allied force of about 2000 men, started towards Peking for the relief of the foreign ministers. This force was transported to Tientsin by rail and from there it proceeded on foot, the railroad above Tientsin being repaired as the troops advanced and used for the transportation of provisions.

Later, on the 14th of June, a force of about 800 allied troops, which had been landed at Tongku, were peremptorily ordered to return to their ships by the Chinese general commanding the Taku forts at the mouth of the Pei Ho. At this, the foreign naval commanders held a conference at which, the American admiral dissenting, it was decided to take possession of the forts in order to avoid further trouble with them, and an ultimatum was accordingly sent to the Chinese general on the 15th, demanding that he evacuate the forts before 2 A. M. of the following day.

Lying in the river at this time were the British ships Algerine, Whiting and Fame; the Russian ships Mandjur, Giliak and Koreetz; the French gunboat Lion; a Japanese gunboat; the

German ships Iltis and Jaguar; and the U. S. S. Monocacy, the latter having orders not to take part in the attack unless *directly* fired upon, and having besides another reason for not taking part, in that she had on board a large number of women and children refugees who could not be disposed of otherwise. Consequently, the foreign force available for the reduction of the forts consisted of the other gunboats named and the 800 British, Japanese and Russian soldiers and sailors at Tongku. The large fleet outside was nine miles away and hence took no part in the fight.

The Chinese forts, three in number, were all well-built mud forts with high walls and a large number of modern breech-loading rifles and rapid-fire guns mounted in barbette behind shields, the largest caliber being 8 inches. There were about 2000 well-armed imperial troops defending the forts and four new torpedo destroyers in the river at the Imperial Dock Yard a short distance above the forts. With this force at his command, the Chinese general did not choose to evacuate, but instead, at 1.30 A. M., on June 16, opened fire on the foreign ships in the river, some of which were anchored at Tongku, two miles above. These, with the exception of the Monocacy, got under way, dropped down the river and returned the fire until daylight, by which time several of the ships had been struck repeatedly, the advantage being clearly with the Chinese.

At daylight the troops on shore advanced, the Japanese and British on the north side and the Russians on the south side of the river, while the ships moved in between the forts and bombarded them at very short range. The British and Japanese troops assaulted the north fort, but were repulsed with considerable loss. They were quickly re-formed and advanced again, the rapid-fire guns of the ships keeping the Chinese behind their walls, when, just as the attacking force reached the wall the second time, a shell from the Algerine exploded the Chinese magazine, which was in an unprotected position above the wall. This so demoralized the Chinese that the attacking force was allowed to scale the walls and, after a short fight, to obtain possession of the fort.

On the south side of the river the Russians were equally successful, and the Chinese were driven out of all their forts. The Chinese lost heavily in killed and wounded. The foreign loss was 70 killed and wounded.

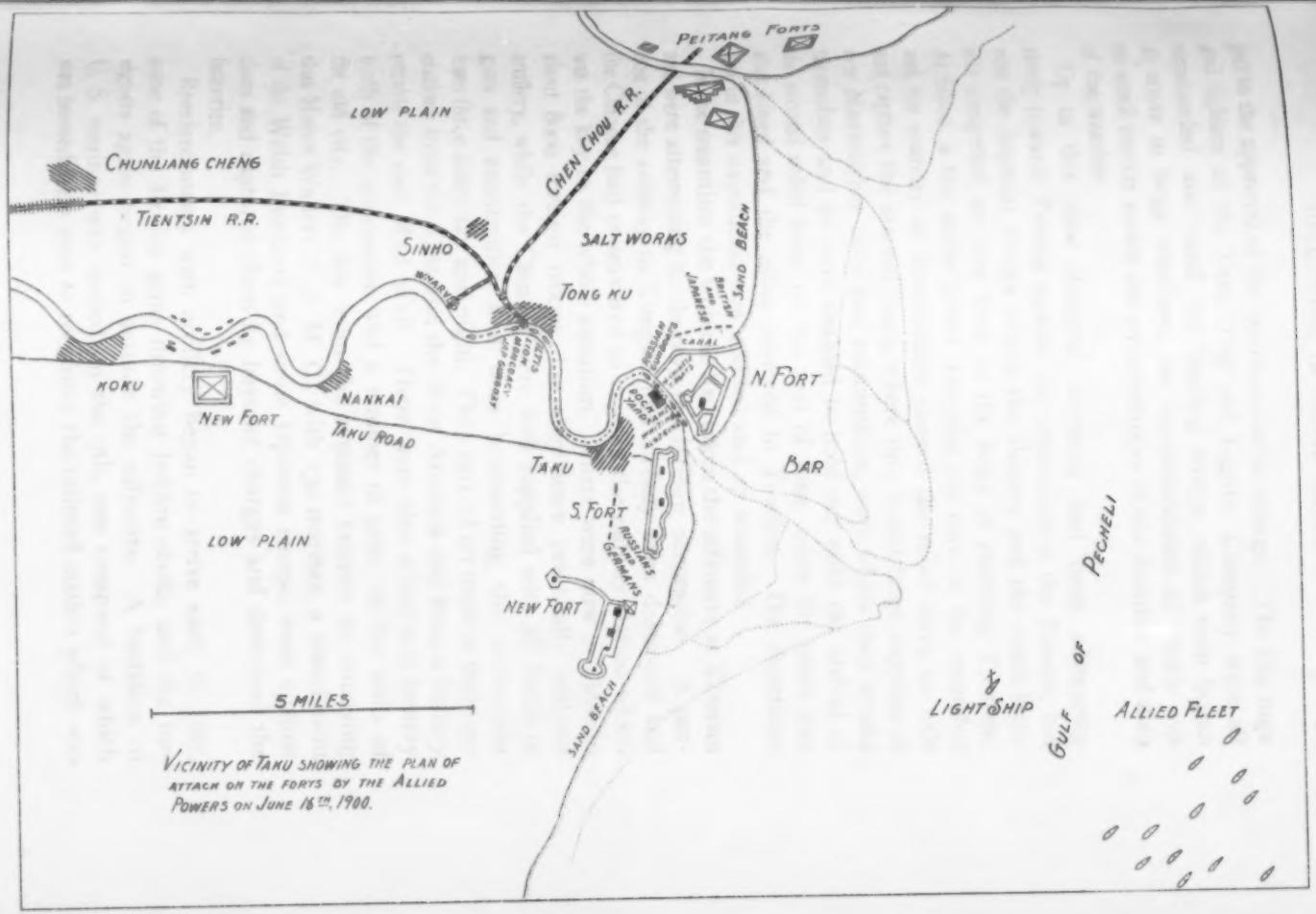
The four destroyers in the river were abandoned by the Chinese crews, taken possession of by the British, and placed under the care of the Monocacy until later, when they were disposed of by giving one to the Russians, one to the French, one to the Germans, while the remaining one was retained by the English. These boats afterwards did excellent service as despatch boats between Tongku and the fleet outside the bar.

The damage to the foreign fleet engaged was as follows:

The Russian gunboat Giliak was sunk by a shell exploding in her magazine, but as the water was shallow, she was afterwards raised and repaired; the Iltis was badly damaged above the rail and had her executive officer and several men killed and her captain badly wounded; the Whiting received a shell in a cold boiler; and the Monocacy, lying at Tongku, was struck by a 6-inch shell which shattered a boat on her starboard side and then passed down and out through the port bow. A number of other shells came near her, and, on account of the refugees on board, she was moved farther up the river out of the line of fire of the north fort on the ships coming down the river, many of the Chinese shells going high and falling in and about Tongku.

The damage to the forts was slight except for the destruction of the magazine in the north fort, and but for the assault of the landing party they could not have been taken. On the advance of the troops to the assault, the ships were from 400 to 1000 yards distant from the forts, and at these ranges were able to drive the Chinese from the walls and even from the guns with shields by means of their rapid-fire and machine-guns.

The imperial troops were dispersed in the direction of the Peitang forts and Tientsin, followed by the Russian troops. A line of Cossack posts was established along the railroad between Tongku and Tientsin and the road put in operation from the former place to where it had been torn up by the Chinese, 16 miles out. By the mutual agreement of the foreign naval commanders, Commander F. M. Wise, U. S. N., commanding the U. S. S. Monocacy, was placed in charge of the railroad, buildings, rolling stock and wharves at Tongku, all of which were to be employed to the best advantage of all the powers. A representative of each of the foreign naval powers was stationed at Tongku, each to look after the interests of his own government in regard to railroad transportation and landing facilities, sub-



VICINITY OF TAKU SHOWING THE PLAN OF ATTACK ON THE FORTS BY THE ALLIED POWERS ON JUNE 16TH, 1900.

ject to the approval of the commandant in charge. The fine tugs and lighters of the Taku Tug and Lighter Company were all commanded and used for landing troops, which soon began to arrive in large numbers, the disembarkation of which was no small matter under the circumstances of the location and also of the weather.

Up to this time Admiral Seymour had been advancing slowly towards Peking against the opposition of the Boxers, but now the imperial troops joined the Boxers and the relief force was compelled to turn back in the hope of reaching Tientsin. At Sikoo, a few miles above Tientsin, the care of the wounded and the scarcity of ammunition caused the relief force to halt and capture the arsenal there, where they found large supplies of new Mannelicher rifles and ammunition, with which they armed themselves and so were enabled to hold out until the arrival of the second relief force on the 21st of June, when the place was abandoned and the allies returned to Tientsin. The American loss in this expedition was 4 killed and 27 wounded.

In the meantime the Chinese had taken the offensive at Tientsin and were attempting to destroy the foreign concession. A portion of the railway to Tongku had already been destroyed and the Chinese had endeavored to capture the railway station which was the key to the whole situation. There were now in Tientsin about 8000 foreign troops, but they were practically without artillery, while the Chinese were well supplied with all kinds of guns and ammunition and were bombarding the concession from three sides day and night. They carried on most of their operations from the East and the West Arsenals and from a battery outside the east Mud Wall. There were also a fort and battery north of the concession and a number of guns on the walls of the old city. The fire from the arsenals became so annoying that Major Waller, U. S. M. C., with 130 marines, a detachment of the Welsh Fusileers and some Japanese troops, went against them and captured them by bayonet charges and destroyed the batteries.

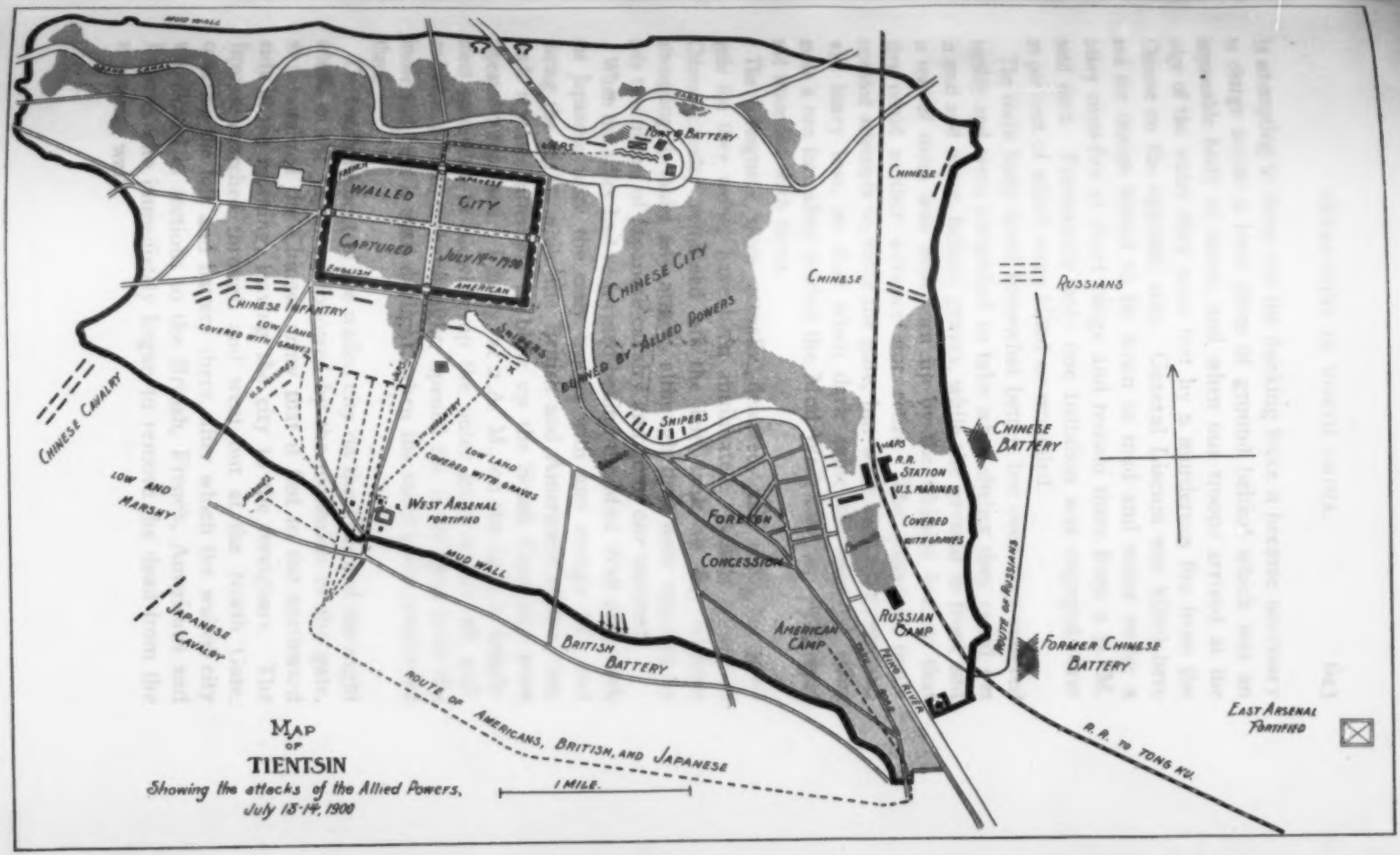
Reenforcements with artillery began to arrive early in July, some of the British guns throwing lyddite shells, and the foreigners again began to assume the offensive. A battalion of U. S. marines was landed on the 9th, one company of which was immediately sent to reenforce the railroad station which was

then guarded by the Sikhs, the Wei hai wei Chinese regiment, two companies of French, and a detachment of Russian troops. A few days later the Chinese made a determined effort to drive out this force and obtain possession of the station. Hand-to-hand fighting took place, whereupon the French troops withdrew across the river, delaying somewhat the advance across the pontoon bridge of a battalion of Japanese troops that were coming as reenforcements. Upon the arrival of the Japanese troops, however, the Chinese were driven back, but they continued to bombard the place until the walls of the engine house were almost shot away and the defenders had to take shelter in the engine pits and cover themselves with railroad ties to avoid the flying bricks. The Wei hai wei Chinese regiment in the service of the British did excellent work in this fight, thus showing the possibilities of the Chinese soldier when properly led.

The 9th U. S. Infantry arrived in Tientsin on the 11th of July, and on the 12th a regiment of Russian artillery was sent up, bringing the number of foreign troops up to about 14,000 men, so that it was decided to attack the walled city on the 13th. The Russians were to capture the batteries along the east Mud Wall and then take the fort and battery north of the concession, while the British, Americans and Japanese were to advance on the south wall of the old city and force an entrance through the South Gate. The success of the latter movement depended upon the efforts of the Japanese to blow up the gate with dynamite.

Early in the morning the allies made their attack. The Russians succeeded in clearing the Chinese away from the east Mud Wall but met with such opposition that they could not get inside the wall to attack the fort and battery to the northward. The other foreign troops went over and through the south Mud Wall at the West Arsenal and advanced towards the walled city under a terrible fire until forced to take shelter behind graves and other obstructions.

The American marines were on the extreme left, with the British next, and then the Japanese, while it was intended for the 9th Infantry to take the right of the line. Owing to a broken bridge and a lack of knowledge of the ground, the 9th became detached from the main body and advanced alone as far as a diagonal road leading to the South Gate. Here they met with both a front and a flank fire which made their position untenable.



Map
of
TIENTSIN
Showing the attacks of the Allied Powers,
July 13-14, 1900

TIENTSIN
Scale
Showing the extents of the Allied Armies
July 13th 1900

In attempting to drive out the flanking force it became necessary to charge across a level piece of ground behind which was an impassable body of water, and when our troops arrived at the edge of the water they were met by a murderous fire from the Chinese on the opposite side. General Liscum was killed here and the troops forced to lie down in mud and water under a heavy cross-fire at short range and remain there from 9 A. M. until dark. Fortunately only one battalion was engaged, over 20 per cent of which were killed or wounded.

The main body fared somewhat better, but even they suffered terribly and were compelled to take what shelter they could get in mud and water, behind graves, while the ground in front and in rear of them was kept torn up by the Chinese fire, so that they could neither advance nor retire. The Japanese made repeated attempts to force the gate, but were each time repulsed with heavy loss, so that when dark came the battered allies made a run for safety behind the Mud Wall, carrying their dead and wounded with them.

The foreigners were actually defeated, and with an energetic foe they would have been annihilated. A heavy force of Chinese cavalry remained off the left flank all day without attempting to make any attack, although they were opposed by only two troops of Japanese cavalry and 50 of our marines.

When the allies had re-formed behind the Mud Wall after dark the Japanese were the only troops with any energy left, and during the night, while the British and Americans rested, they made repeated attempts to blow up the South Gate and were repeatedly repulsed. Finally, at 2 A. M., on the 14th, a detachment succeeded in blowing up the outer gate, scaled the wall, and after a hand-to-hand fight, opened the inner gate from the inside and held it until daylight, when the main body reenforced them.

The bombardment of the walled city on the 13th and the night attacks of the Japanese, followed by the explosion of the gate, so demoralized the Chinese army that it fled to the northward early in the morning, leaving the city to the foreigners. The Japanese marched through and went out at the North Gate, capturing the fort and battery there, after which the walled city was allotted in sections to the British, French, Americans and Japanese, who immediately began to remove the dead from the streets and walls.

The city was a terrible sight after the battle. A large portion outside the wall had been burned and fires had also broken out inside in many places, while the dead were lying in heaps on the battlefield, on the wall itself, and in the streets. There had been much destruction by shell fire, which, together with the blackened and deserted streets, made a picture of desolation seldom seen in modern times. No quarter was asked nor expected, the entire population leaving the city and flying to the country for safety, while the foreign troops proceeded to loot the city. In two days Tientsin was changed from a rich and important city of over a million inhabitants to a burned and battered heap of ruins.

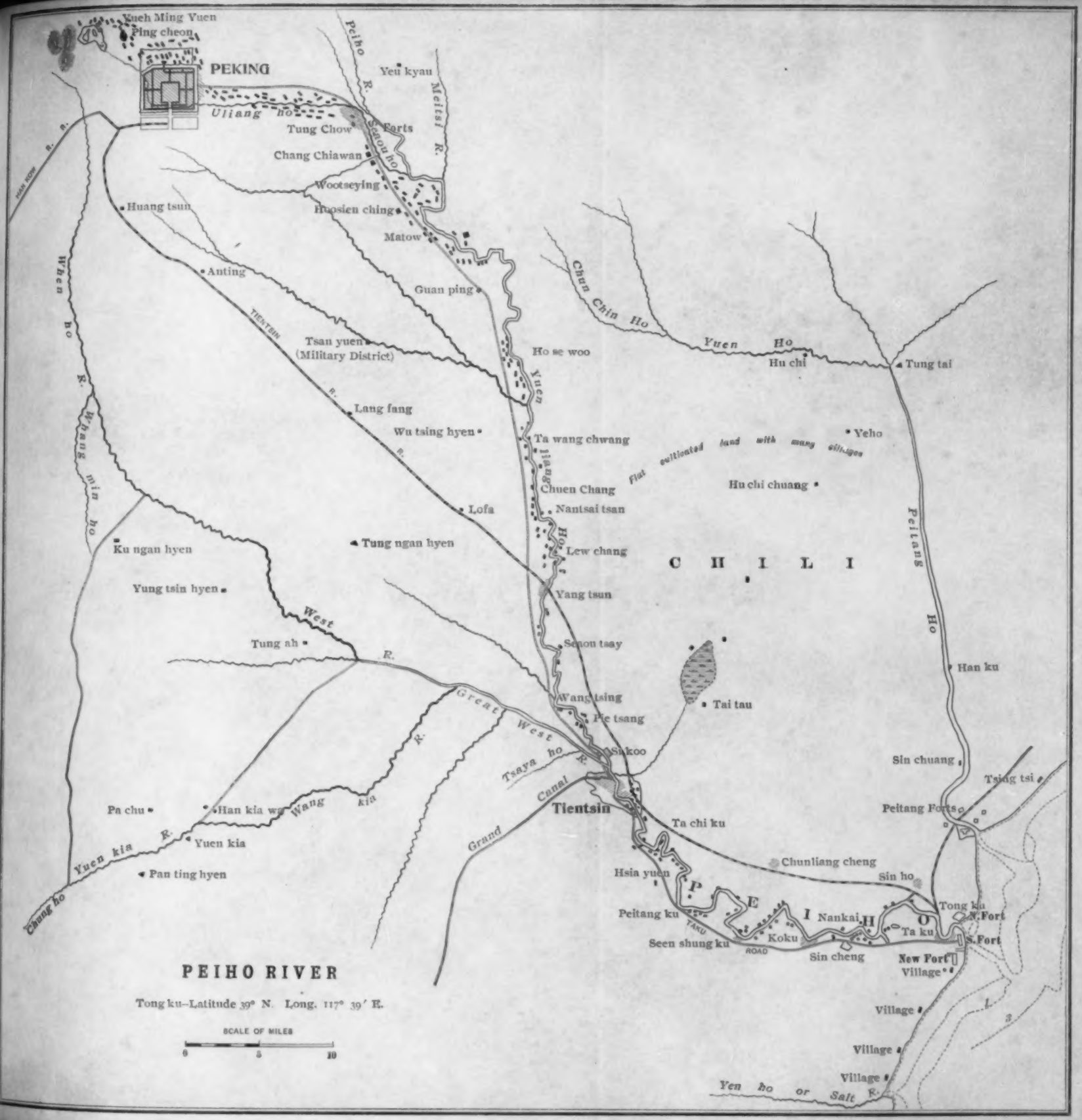
In and about Tientsin, during the fighting, the foreigners lost nearly 2000 men in killed and wounded, while a very conservative estimate places the Chinese loss in killed alone at 10,000.

Two days after the fall of the city the inhabitants began straggling back to their homes, each individual relying for protection on a small painted flag of the nation in which he seemed to have the most confidence. On the approach of any foreign soldiers the refugees would drop on their knees and grovel in the dirt. After a few days the city was patrolled, the looting stopped, and a proclamation issued inviting the Chinese to return to their homes and assuring them protection in their legitimate business.

Guns and arms of all kinds were captured in the arsenal, and nearly four hundred thousand dollars in silver bullion were found in the mint, while evidence was also discovered showing the complicity of the Viceroy of Tientsin in the early movements of the Boxers.

Preparations were now made for the relief of the foreign ministers in Peking, from whom no news had been received for over three weeks, and when last heard from were being constantly bombarded. On the 24th of July a runner came through with messages from the ministers saying that a truce had been agreed to and that there had been no fighting since the 17th, but that food and ammunition were getting scarce.

On August 4, a force of 14,000 Japanese, 6000 Russians, 2000 British, 2200 Americans, and about 3000 French, Germans and Italians advanced from Tientsin on both sides of the river towards Peking. On the 5th, at Pietsang, a hard battle was fought in


Yueh Ming Yuen
Ping cheon
PEKING
Yeu kyau
Peiho R.
Meitsi R.
Uliang ho
Tung Chow
Forts
Sanou ho
Chang Chiawan
Wootseying
Huosien ching
Huang tsun
Matow
Anting
Guan ping
Chun Chin Ho
Yuen Ho
Hu chi
Tung tai
Ho se woo
Yuen ho
Tsan yuen
(Military District)
TIENTSIN
R.
Lang fang
Wu tsing hyen
Ta wang chwang
Yeho
Flat cultivated land with many villages
Liang ho
Chuen Chang
Hu chi chuang
Lofa
Nantsai tsan
Ku ngan hyen
Tung ngan hyen
Lew chang
C H I L I
Peitang Ho
Yung tsin hyen
Yang tsun
West R.
Tung ah
Sanou tsay
Han ku
Great West R.
Wang tsing
Tai tau
Pe tsang
Sukoo
Sin chuang
Tsing tsi
Tsaya ho R.
Canal
Tientsin
Peitang Forts
Pa chu
Han kia wa
Wang kia R.
Ta chi ku
Yuen kia R.
Yuen kia
Chunliang cheng
Grand
Hsia yuen
Sin ho
Pan ting hyen
P E I H O
Peitang ku
Nankai
Tong ku
N. Fort
TAKU ROAD
Ta ku
Koku
S. Fort
Seen shung ku
Sin cheng
New Fort
Village
Village
Village
Village
Yen ho or Salt R.
Chung ho
Yuen kia R.
Wang kia R.
Hsien kow R.
Whan ho R.
Wang min ho
PEIHO RIVER
Tong ku—Latitude 39° N. Long. 117° 39′ E.
SCALE OF MILES
0 5 10

which the Chinese were defeated, and on the following day at Yangtsun they made another stand, but were driven out, the Americans losing heavily in the attack, and later from the fire of the Russians owing to an error. From Yangtsun to Tungchow there was little fighting, but the march was very trying on account of the heat. After a short rest at the latter place the allies moved on Peking, the Japanese and Russians attacking the north wall, the British the east wall, and the Americans the south wall, all entering the city after very little opposition and finding the legations still holding out against heavy odds.

With the relief of the minister, the operations of the American army were practically over with the exception of a fight of the 6th Cavalry, together with a detachment of the Bengal Lancers and some Japanese troops against a force of about 4000 Boxers six miles from Tientsin on the 19th. After considerable skirmishing, the 6th Cavalry made a charge, routing the Boxers and killing over 400 of them.

After the first few weeks of operations it was readily seen that the Japanese army was far ahead of all others in organization, discipline, endurance, equipment, and second to none in fighting. The detail to which their organization was perfected could best be seen on the battlefield, where their ammuition supply was so perfect that, besides looking after themselves, they still had time to assist the British and Americans in bringing ammunition from the city for the troops under fire. Our own wounded can testify to the efficiency of the Japanese Field Hospital Corps at Tientsin, even when the Japanese loss was over 18 per cent of the troops engaged.

Besides observing the relative merits of the various troops off duty as well as in the field, there was abundant opportunity to study the various methods of landing from transports under varying conditions. In the beginning the Russians and the British used large lighters towed by tugs, but this was advisable only when the lighters could be towed direct to Tientsin without stopping and the troops marched ashore. The best method of landing troops from outside the bar, and the one finally adopted by all nations, was to use light-draught river steamers which would carry from one to two battalions with supplies enough for 48 hours. These could load in all kinds of weather, were of only slightly greater draught than the lighters, and having their own

steam were independent, so that in the river they were much safer and more easily handled, while the men were more comfortable on board and could be landed in better condition. Similar steamers were used for landing horses and artillery, and while slightly more expensive than lighters, they were also more expeditious and, under the conditions obtaining at Taku and Tongku, much more practicable, as there were landing docks to which the steamers could be made fast at any stage of the tide.

After landing, the troops were transported to the front in various ways, the Russians and the Americans using the railway almost entirely, although some tugs and lighters were also used on the river. The British used tugs and lighters after their troops had been landed from steamers at their station at Sin ho, a few miles above Tongku. The Japanese used the railway until it was turned over to the Russians, after which they marched their troops overland via the Taku road to Tientsin and found it a very practical method, their men arriving in good condition and ready to take the field.

The greatest objection to using long lighters was the danger of grounding in the river bends at high water or on a falling tide and having to remain until the next high water, frequently blocking the river or forcing other vessels aground.

The naval operations in this war were necessarily confined, but nevertheless important, for besides keeping communication open between the armies and the outside world, the various navies kept the few Chinese ships blockaded so that they could not interfere with transports or the landing of troops. Early in the struggle the greater number of the men on shore were marines and bluejackets who had to receive all supplies from the ships. A number of naval guns were landed, mounted on improvised carriages and made to do excellent service in the fighting at Tientsin. And the old Monocacy, although she took no part in the fighting, did sufficient good work as an international headquarters while she was in the river to cause her to be remembered by all nations which took part in suppressing the "Boxers."

DISCUSSION.

"TORPEDO OPERATIONS IN NAVAL WARFARE." See No. 95.

Lieutenant-Commander W. IRVING CHAMBERS, U. S. N.—The lecturer admits that warfare by diagrams is a highly unsatisfactory though excellent mental exercise, and I agree with him. It is like any game in which chance as well as skill enters as a factor. The subject is treated in a systematic way that shows an intimate knowledge of the present state of torpedo warfare, and I am entirely in accord with him in the main. I wish, however, to point out a few particulars in which I differ as to detail.

1. In regard to the balance adjustment of the gyroscopic steering device, I presume the lecturer refers to the difficulties experienced with the instrument now in common use. I am confident, however, that the newer instrument will be provided with a fixed or shop adjustment which will permit of disassembling and of rough usage without danger of disturbing this adjustment. At any rate, I don't think the mechanical difficulties in the way of accomplishing this end are so great as to justify the tactical conclusion that the instrument will not be used far from a base or position suitable for readjusting it.

2. As to the attack by torpedo-boats, the occasion is one during which boats and quarry are obscured. The boats do not know the exact position and heading of the quarry until they are almost "on top of him." They are going at full speed straight for him, after the alarm is given, expecting to discover his heading and movement in time to pass across his stern or bow, but always to leave him on the port or starboard hand, as specified in the "plan of attack" agreed upon. There is to be no circling about until well beyond the quarry, and then all are to turn in a direction before agreed upon and rendezvous in a predetermined way. I should, therefore, prefer to have the torpedoes of two tubes on the engaged side, one at 20° to 35°, the other at 45°, and both with gyroscopes set so that the torpedoes would pursue courses parallel to the keel after they had turned through those angles. The gyroscope of the third tube I would have set at zero and the tube ready to train in any direction for a chance shot, direct, at short range, at some other ship, or for a parting shot at the first ship, according to the opportunities presented. This, of course, is a matter about which there will probably be diversity of opinion.

3. I agree with the lecturer in setting the gyroscopic gear for certain angles before advancing to attack in the case of torpedo-boats, which operate at night or when the quarry cannot be clearly seen; but when

using torpedoes from ships I would prefer to be able to change this adjustment at will. This adjustment is simple and can be made almost instantly at the side of the tube and just before firing. It simply requires the turning of a small crank (one turn representing a change of 10°) until the pointer shows the number of degrees desired. It does not necessitate any "handling" of the torpedo—unless the lecturer refers to the way it is installed in certain foreign torpedoes—so that it is possible for an observer in a protected position, with a chart of the possible curves of the torpedo (all referred to the keel line of the ship) before him and an alidade pointing constantly at the enemy, to know at any instant at what angle to set the valve of the gyroscope, in order to have the torpedo strike the enemy at the end of the interval of time required for the torpedo to make its run. These angles can readily be anticipated in ample time to communicate with the torpedo-room and have the adjustment made or changed as desired.

4. A torpedo should always be aimed at a ship's broadside and never directly at either end of a ship. One of the main ideas governing the design of this new gyroscopic steering gear was to make it possible for a torpedo to be aimed so as to strike the broadside of another ship approaching end on. Take the case of a ship provided with two submerged tubes at right angles to the keel line. If another ship, say 300 feet long, should be caught in her wake, or nearly so, end on, the fire of both torpedoes could be converged across the stern to strike the broadside of the approaching ship, when it has arrived at the desired distance, say within 600 yards of the position at which the torpedoes were fired. And the target presented would permit an error of about 10°, or 5° each way, in the setting of the valve. With the 5-meter torpedo, having a tactical diameter of 300 yards, the case is analogous to aiming a torpedo from each of the extremities of a base line about 600 yards long at an intermediate object 100 yards long, perpendicular to and 600 yards from the base line.

I mention the case of a ship approaching from astern because certain theorists, who have threshed it out diagrammatically, claim that it is easiest for a ship to deliver a ram attack by approaching astern of the ship to be attacked.

There was a time when the end-on charge or the ram attack, bows on or bows crossing, was considered the first aim or object in a naval mêlée, or even in an engagement between two ships, and this may have been in the mind of the lecturer when he denounced the torpedo as a defense against the ram. Contrary to his conclusions, however, I believe that the torpedo has no place on board of a ship unless it can be regarded as a defense against the ram. I believe that it can be used as such a defense very effectively. I think that the bows-on charge will be used only as a last resort or accidentally, as when two ships find they cannot escape it. At any rate, it is a demonstrable fact that the surest and easiest way for a ship to deliver a ram attack is to do it in chase of her antagonist; therefore it is a comforting thing for the ship being chased to have a ready means of defense by torpedoes and to know that

the chasing ship cannot use her torpedoes as soon as the ship being chased. I dwell upon this because I differ entirely from the lecturer when he says: "I believe no officer will ever do anything with the torpedo who waits for his enemy to come within reach. There is but one way to use the weapon, even in the defensive, and that is to go in search of your adversary and deliver upon him the most vicious attack that you can possibly contrive. . . ." Now that is just what would be expected of an ardent commander conscious of his superior speed. But in single engagements outside of torpedo range, one rule may be laid down: *You can always bring your adversary to bear either directly ahead or directly astern.* And if you have the nerve to turn away and bring the fast antagonist in your wake, you have the very best chances to torpedo him when he gets close enough. The probabilities of the case are that the slower ship will have the more powerful armament and best armor and that, with the faster adversary astern and the range changing in the slowest possible way, the vicious attack will be settled by gun-fire long before there is a chance to use the torpedoes. I don't say that I advocate these tactics for the slower ship; but I am not one to sneer at the idea when the advantage of having the enemy in your wake is suggested, because I believe it requires more nerve, less recklessness and more skill to maneuver in this way. Nevertheless, I can readily imagine that the "stern-to" tactics might come about as a matter of course, or by orders, in a fleet action where, in case of a separation from the rest of the fleet it would be tactically imperative to rejoin the other part or to place the superior force astern in an endeavor to lure a portion towards the united body of your own force.

In a bows-on ramming attack, I also think the slower ship would have a trifling advantage in the use of torpedoes for defense when capable of quick adjustment for the angle of run. Owing to the uncertainties attending this reckless form of attack, in which a superior vessel subjects herself to possible annihilation by an inferior one, it is impossible to set the angle of the torpedo beforehand to cover all the changes that may ensue; but if the angle may be quickly changed to meet the conditions at a critical time, one or both ships are sure to be torpedoed, and therefore the "vicious" attack is apt to be confined to gun-fire until some advantage be gained. This is, of course, giving your antagonist credit for equal skill in handling both ram and torpedo.

5. In regard to submarine boats, of course they are for use in daytime, *i. e.*, they may be used during daylight when it would be folly to use surface boats. They are necessarily slow, but I fancy that the difficulty of seeing or of navigating them as intended will be no greater than that attending the surface boat on a dark night; but when the boat comes up for a final sight to point her submerged torpedo, her chances will be rather slim unless she can quickly adjust the angle of the gyroscope. In other words, she cannot depend on a fixed adjustment of that angle. Fortunately, we are able to quickly adjust this angle from 0° to 140° on either side of the tube.

Before leaving this friendly criticism, I wish to strengthen the lectur-

er's remarks by inviting an inspection of the charts of the Maine coast. Take Casco Bay, for example, C. S. Chart No. 315, where there are many ideal positions inviting their seizure as bases of operations by a powerful naval antagonist. These positions would be difficult to defend by guns, mines and army alone; but they are, fortunately, ideal positions for the operations of torpedo-boats in defense.

I wish to mention some important things that are absolutely essential to the success of a torpedo-boat, because in some of our latest boats they have been neglected.

1. No torpedo-boat should be obliged to rely upon the ordinary bell-pull and gong for communicating orders from conning-tower to engine-rooms. The best arrangement is that on the Porter and Dupont; that on the Dahlgren and Craven is absurd and fatal to success.

2. The reversing gear of the engines should infallibly admit of engines being instantly reversed from full speed ahead to full speed astern.

Captain CASPAR T. GOODRICH, U. S. N.—It is always pleasing and instructive to read the opinions of an author who is fully possessed of his subject and who has the rare faculty of expressing himself clearly and gracefully. The torpedo could certainly have no more convincing advocate than the able lecturer of the Naval War College whose address is the subject of the few and unimportant observations I may have to offer. There is, in my judgment, no surer road to correct theorizing than the ardent exposition of any given thesis by one familiar with its details, followed by honest discussion on the part of those who do or do not agree with the pundit. In many respects I find myself among Lieutenant Chandler's disciples; in others, I am forced to range myself among the sceptics.

I cannot share with him the belief that torpedo vessels of foreign powers need not be looked for on our coast simply because there are in certain European navies extreme partisans of the torpedo who will doubtless succeed in impressing their views on the technical details of the campaign; and not because such measures are commendable. Herein the lecturer and I are really at one. We both think this employment of the torpedo vessel essentially unsound. Our only difference is that he credits the foreigner torpedo enthusiast with an openness to logic which I am disposed to deny him. The untoward result of so incorrect a use of the torpedo the lecturer has accurately noted. If the torpedo vessels come they will, as he points out, prove more of a hindrance than a help to the escorting fleet.

For all practical purposes, the lecturer's analysis of the general strategic situation—"that neither power would try to carry on any serious operations near the bases of the other until the hostile heavy fleet had been driven out of being"—is true.

It is with reluctance that I find myself again compelled to cry out against the oft-recurring proposition to subdivide and localize our defence. As Sir George Clarke, the ablest living writer on military affairs, expresses it: "The sum which a nation can spare for naval and military

purposes is practically limited, and all superfluous expenditures upon coast defence entails loss upon the *sea-going fleet* * and the fleet and the field army, which are the real arbiters of war. . . . Americans who have marked the vigor and the initiation, the skill and daring displayed by their navy in the recent war cannot fail to understand where lies the true defence of their coast." We of the navy should not abate one jot or tittle of the contention that in its sea-going fleet our country must and will find all possible guard against serious harm. Whatever will tend to aid the fleet in this work deserves consideration and sometimes acceptance, but everything afloat must be under the absolute orders of the commander-in-chief. His powers cannot be shorn if he is to be held—as he ought to be, and will be—responsible for results.

This torpedo flotilla based on the assumed need of self-sufficient strength at each point is but the cropping out afresh of the old idea which Proteus-like appears in every generation to bring confusion into our councils. To it we owe the gunboats of Jefferson's time. To it we owe the recently constructed monitors.

There is no more important lesson to be taught our non-combatant population than a generous trust in the navy for its defence. To pile up needlessly elaborate fortifications, to place monitors and sections of torpedo-boats at every point of our coast is to stimulate a sense of unrest and an apprehension of danger which will inevitably render each community clamorous for more and still more protection, no matter how much other cities or states are sacrificed.

In saying this I may be entirely wrong, but I hold that the burden of proof rests with him who proposes so large an expenditure on a special weapon as the lecturer's scheme of 231 torpedo-boats would involve. My part in the discussion is done when I say that I see no possible necessity for such a development, that I do not accept the basis of subdivision and localization, and that I am quite ready to be convinced of my error. He has the floor and the attention of the whole service. If he can establish this fundamental point beyond peradventure, we will all join with him in furthering his ends.

If my expressions appear to be strong, they must find their excuse in a profound conviction that the policy suggested is one which should be combated seriously and unremittingly.

The lecturer's section "Approach to the Enemy" is admirably conceived and worked out. His method of solving the problem "By assuming the most favorable circumstances I could think of, I have been able to represent certain maneuvers as carried out in what I consider to be the theoretically perfect manner" being correct, he need not fear for his results. They commend themselves to general approval. The same may also be said of his interesting and instructive studies of other torpedo-boat tactics.

The proposition to hamper our battleships with torpedo launches does not strike me favorably. Many things that might be useful under certain

* The italics are not the author's.

conditions are omitted from a vessel's equipment, and I am quite sure that the torpedo launch does not come under this category.

On the value of the torpedo-boat in coast defence, there is little difference of opinion. This seems to be its especial rôle.

The lecturer realizes the chance of fatal error when torpedo-boats are used in fleet actions. I find that in reading the lecture over for the first time I pencilled these words in the margin of paragraph 38: "Does not this seem to depreciate the value of the torpedo-boat in this connection?"

For the automobile torpedo from shore, I strongly recommend the substitution of the dynamite gun. It has longer range, more accuracy of aim, swifter flight, greater explosive charge.

Sooner or later I am confident that a true appreciation of the torpedo will prevail, that it will be recognized as a special tool requiring special appliances for its use, and that it will disappear from all vessels except those built to carry it as their chief or only means of offence. We were wise, in my judgment, to abolish the torpedo from our cruisers. I expect to see it taken out of our battleships before many years. Its only reason of existence lay in that it was the tactical reply to the ram. The lecturer throws doubt on even this employment. Let it go. The gun is the real arbiter of actions between ships. In these days of quick-firers it is difficult to imagine even two armored vessels getting within reasonable torpedo range without one's punishing the other beyond the elastic limit. I do not mean to say that a torpedo might not possibly be useful on occasion, but I think the occasion so unlikely to arise that the battleship may properly take that chance and get rid of a weapon that is bothersome in itself and bulky in its mounting and its accessories. However, so long as torpedoes are still retained on heavy ships, their captains will do well to study attentively the excellent suggestions made by the lecturer in Section D of his address.

In referring to submarine boats, the lecturer very quietly gives them the thrust of Ahab, when he says "it is no more possible to see under water than it used to be." Personally I think attacks from balloons will find their place in serious naval warfare about as soon as attacks from submarine boats. I had always hoped that their development would remain the exclusive monopoly of the French and Spaniards. I am sorry to see the Anglo-Saxon mind distraught by such spooks.

In his summing up, the lecturer has put the gist of torpedo warfare into a few plain phrases. Practically he says that a man who is bound to have *your* life even if he has to sacrifice *his own* is a dangerous fellow. Put such a man into a torpedo-boat and the enemy must needs keep a bright lookout, have plenty of patrol boats, be always on the move, always on the alert, or his doom will be sealed, no matter whether the torpedo man has the latest mechanical devices at his command or not. There is nothing in the history of our navy to indicate the lack of such officers when they are needed. But cool and brave as they may be by nature, they will be better able to translate wishes into deeds if they read attentively this essay which Lieutenant Chandler has so favored the navy by writing.

Lieutenant R. C. SMITH, U. S. N.—The lecturer adopts a very prevalent view, that the destroyer is simply a large torpedo-boat. But is there not room also for the opposite view, that the destroyer is only incidentally and occasionally a torpedo-boat, and primarily a gunboat to protect the fleet against torpedo-boats? A fleet on the enemy's coast at night really has no other defense against torpedo-boats. A cordon of destroyers affords a reasonable protection, assuming fleet and boats thoroughly drilled at cruising formations. All who have taken part in torpedo-boat drills realize that the searchlight is an advantage to the boats rather than to the ships, except in the one case in which narrow channels are flooded by fixed beams, as was the case at Santiago.

The fleet at anchor may have vedettes and pickets inside the destroyer cordon, but at sea destroyers only will be available. The launches mentioned by the lecturer are in effect the English vedette launches, and we could not do better than carry one or two of them in all our heavy ships.

As to sending destroyers abroad, if the fleet goes, it is hard to see how they are to be dispensed with, provided the enemy has torpedo-boats. It is true the Spaniards did not have great success, but that is hardly a criterion. A destroyer of 400 tons with liquid fuel and a trained crew, not a crew of officers and men put aboard for the trip, ought to be able to go anywhere.

But leaving out the question of destroyers, every one must realize that if torpedo-boats have a mission anywhere, it is right on our own coast. If the enemy cannot bring over destroyers, so much the better for our boats. And as to organization, Lieutenant Chandler's district scheme seems perfectly feasible.

The Germans have spent much time in perfecting the tactics of boat attacks. It is hard for an outsider to see the value of their very close order formation, except as a training in maneuvering. It, of course, ensures that the attack by all the boats should be simultaneous, but if the boats could separate earlier and come in on entirely different bearings, the chances would apparently be more favorable. Drills undertaken on our own account could determine some of these points.

The lecturer's stand in reference to the character of installations aboard other than torpedo vessels does not seem open to criticism. It it probable that many officers would like to see torpedoes relegated to torpedo vessels exclusively. This would simplify matters, but as long as the weapon continues to improve in range and accuracy, and is included in the armament of foreign battleships and heavy cruisers, no one nation can afford to take the lead in dispensing with it.

Torpedo stock, for a variety of reasons, is at low ebb with us at present. The Spanish war is partly responsible, not only in the popular mind, but even in the service itself. Officers who have given thought to the matter and have some practical acquaintance with the weapon know that there was not an atom of evidence either for or against torpedoes. The present scarcity of officers and men is no doubt the main reason for not keeping the flotilla in commission. Yet the boats are much needed for

drills and exercises to settle many of the points brought up by Lieutenant Chandler and to train and develop the personnel. A boat laid up in ordinary is supposed to be ready to take the water and move out at a couple of days' notice. Officers, however, who are familiar with the duty, know that such a boat with a pick-up crew will not reach a point of efficiency inside of six months.

The moral, then, is that to develop a torpedo system, we need drills with ships and boats afloat, we need the boats in commission, and we need officers and men to man them and stay in them long enough to show what can be done with them.

Lieutenant JOHN M. ELLICOTT.—Lieutenant Chandler has gone into the subject so thoroughly that I would refrain from criticism if I did not differ most radically from him on one point; viz., the section formation for seeking and approaching the enemy. That, I think, would be a tactical blunder for the following reasons:

(*a*) It reduces to a minimum the chances of finding the enemy; seven boats searching in a bunch having no better chance than any one of them searching singly.

(*b*) It raises to a maximum all the causes tending to discovery, such as the bow waves, the phosphorescent wakes, the volume of smoke, the volume of noise, the flaming and sparking of funnels, and the size of visible target.

(*c*) It insures the discovery of all the boats at once if any of these multiplied causes draws attention to the section.

I think torpedo-boats should go out singly, by as many different exits as possible, and at quite long intervals apart; the boats to seek separately certain stations enveloping the enemy, but beyond range of discovery; then, at a certain time, which by prearrangement will have allowed all to reach their stations, all the boats should concentrate at slow speed toward the supposed center of the enemy's formation. When any one boat is discovered by a vessel of the enemy before successfully discharging a torpedo, all neighboring boats should concentrate upon that vessel.

My tactics would be dispersion for search; concentration for attack.

Lieutenant J. HOOD, U. S. N.—I have read Lieutenant Chandler's lecture on "Torpedo Operations in Naval Warfare" with great interest, and find in it much to be commended, and all to be of value, as opening up for study and discussion many points of torpedo warfare but little considered by the average naval officer.

While not quite the enthusiast on the subject of the torpedo as a naval weapon that the lecturer is, I am a firm believer in its great usefulness and capabilities when properly handled; and think Lieutenant Chandler deserves the thanks of the entire service for ventilating and bringing into prominence so many points of a weapon that may be so valuable and that can be so useless when not properly handled and understood.

In complying with the "Institute's" invitation to discuss and criticise Lieutenant Chandler's lecture, I will only mention a few of the points brought out in which I disagree with him.

1st. I think the lecturer is in error in assuming that torpedo warfare is not to be feared on our own coasts in case of conflict with European nations. I believe that any country with a navy considerably superior to ours—and there are many such—could, and would, bring over and use its destroyers from the beginning of the war, and before our "fleet in being" had either been destroyed or securely cooped up. There are too many bays, sounds, etc., on our coasts indefensible against a largely superior naval force, that such a force would control and use as a base, without necessarily securing a hold on the land itself. It is hardly to be supposed that an intelligent and alert enemy would deprive himself of the use of such powerful auxiliaries, when the means of obtaining them were so easy and feasible. The case quoted of the Spaniards in the late war could hardly be called an illustration of the contrary, as their navy was considerably inferior to our own, and the Spaniards could hardly be called either intelligent or alert enemies.

2d. I think that the lecturer's ideas on the organization of the coast into 25 districts with 175 torpedo-boats and 56 destroyers are Utopian, and, on the whole, unnecessary. Such an extensive torpedo-defense scheme might be necessary were the entire coast-defense system turned over to torpedo-boats alone. But it is out of all proportion to the other necessities of the navy both as it is or even as it should be. It would be anything than good policy to advocate the extension of the torpedo system at the expense of the real fighting force of the navy, as would necessarily follow such an extensive program as that laid down by the lecturer. A quarter of the number of boats and half the number of destroyers suggested would answer all the purposes of national defense; and any further money available for naval expenditure could be far more valuably used in the building of fighting ships proper.

3d. The general statement made by the lecturer, that the great and proper sphere for torpedo action is coast defense, is thoroughly sound, and I agree with him in that entirely. But in the method of conducting this coast defense I believe him to be in error.

Actual experience of both the modern torpedo and torpedo-boat in war has been so limited that little deduction can be drawn from it. But so far as it goes, it would, to my mind, seem to lead to the conclusion that the greater chance of success is with what might be called a "still hunt" by boats acting singly—though all the boats available should be sent out at the same and most advantageous time—rather than by sending them out in bunches or sections to hunt as a pack. Nothing in war is so distinctively "personal" as torpedo-boat work in actual service. Success depends absolutely and entirely on the care, judgment and daring of the individual. Failure on the part of one in a bunch of seven, or any other number, would lead to a detection of the whole, and defeat the attack before it was made.

The case under consideration, and of which the lecturer is treating, is

the case of a port blockaded, and an effort is to be made to break up the blockade and destroy as many of the enemy's ships as possible by torpedo attacks.

The blockading ships are known to be in the vicinity of the port, and the torpedo-boats must find them and remain themselves unseen till the moment comes to discharge the torpedoes, or failure is almost certain.

The most favorable opportunities are chosen, and the boats are sent out to make the attack.

It would seem to me that under such conditions the chances of getting out unperceived and finding and destroying the enemy are far greater if the boats are dispersed from the instant of breaking cover, rather than hunting in bunches, and dispersing after an enemy is sighted. Moreover, it must be remembered that the enemy will be dispersed also, and the whole force of the torpedo attack might be expended on one ship, when it might be just as easy and feasible to bring down several. One torpedo will sink a ship as surely as twenty.

It may be very pretty in theory, and very excellent seamanship practice, to steam about in a beautiful wedge-shaped formation, but it seems to me that the seven boats in the wedge would be far better occupied in devoting their whole attention to the stalking of their game; and acting singly would cover much more territory, run less risk of detection, and the detection of one would not necessarily lead to the discovery of the others.

In other words, and as a general proposition, I believe that, from the very nature of the case, such a thing as "torpedo-boat tactics" in the face of an enemy is a chimera; and that the whole art consists in the highest possible training of the officers and crews of the boats individually; and then sending them out—as many always as are available—each to do his best independently of the others.

Lieutenant-Commander BRADLEY A. FISKE, U. S. N.—It would surely be a most unreceptive mind that would fail to be impressed with the enormous possibilities of torpedo warfare by reading Lieutenant Chandler's paper; and to all, it opens up a wide and entertaining field for thought about torpedo warfare as it now is and torpedo warfare as it may be made to be.

While some points might be raised about the details of Mr. Chandler's plans, it seems to me that the main point to be considered now is whether the torpedo can be made so reliable that torpedo warfare ought to be attempted on so large a scale. If this be answered affirmatively, both general and special methods of torpedo operations can be worked out afterwards in actual service.

To some, it may seem that Mr. Chandler goes too far, that he depends too much on a delicate apparatus, that he hopes to base a system of warfare on a mere machine; for there is still a deep-seated mistrust of the torpedo, as a weapon to be depended on. We all mistrust the torpedo in fact; and not only for the reason that it is complicated, but for the further reason that it is constantly being changed, and that every change is an addition, a new thing to get out of order.

If we analyze our mistrust, however, and are candid with ourselves, I think we shall see that it is not the torpedo that we mistrust, so much as the men who are to handle it. The torpedo itself is not alive, though it often seems to be so, and perverse besides; but it is really only brass and iron, and will do exactly what men make it do. So the question seems to me to be, not can the torpedo be depended on to do all the things that Mr. Chandler expects, but can we drill our officers and men so that they can make it do them?

Thus regarded, this question becomes like one presented in every department of the naval service, the question of what degree of complication and difficulty can be managed in any weapon or apparatus, remembering the kind of men who are to manage it, and the amount of skill that can be drilled into them. Probably, all of us agree that the apparatus in our newest ships is superior to the personnel that manages it; and we know that the reason is, that we draw on the highly specialized engineering facilities of the whole world for our apparatus, but only on our meagre stock of officers and men for our personnel; so that, in every department of the service, we are confronted with the question of how high can we raise the standard of the men up to the apparatus, and how far we must lower the standard of the apparatus down to the men. Therefore, in considering the question of employing any weapon, or of employing it in any specified way, we must answer the question: "Is the work which the weapon can do, if perfectly managed, so very valuable that we can afford to devote to it the required money, time and drill?"

Testing Lieutenant Chandler's ideas about torpedo warfare according to this standard, the question becomes: "Are the results attainable, supposing the torpedo perfectly managed, so very valuable that we can afford to devote the necessary money, time and drill to attaining them."

Who can answer this question negatively? Is not the question answered affirmatively as soon as stated? To me it seems that we are forced to develop the torpedo to its utmost, and that we *can* develop the officers and men up to its level. Even specializing may become necessary as the torpedo grows; though specializing has its dangers. But that we can educate men to handle torpedoes in the way Mr. Chandler wishes, who can doubt, that knows the keen, resourceful gunner's mate of to-day, and compares him with the non-cerebrating, gun-polishing quarter-gunner of only a few years ago?

Perhaps I can sum up my comment on Lieutenant Chandler's paper by saying that I think torpedo warfare can be made to be all he says, and that it simply remains to educate the officers and men up to it. That this will be easy work, let no man think. It means hard study and careful thought; it means an intimate acquaintance with every screw and spring; it means ability to diagnose at once any hidden trouble; it means long days and nights of practice in the worst of weather; but it can be done.

The fact that the torpedo has recently become effective at 1500 yards; that the torpedo just developed is fully twice as efficient a weapon as that of only two years ago, and that improvements of various kinds are

in plain sight, seem to force us to the conclusion that we absolutely must educate our officers and men, first to manage the torpedo itself, and then to conduct torpedo operations.

Lieutenant W. S. CROSLEY, U. S. N.—Though invited to criticise the article written by Lieutenant Chandler for the Institute, I cannot, in the main, do so. From a brief personal experience in a torpedo-boat, I have been forced to certain beliefs in regard to their use, and I heartily endorse Lieutenant Chandler's article as a whole.

I believe fleet or section tactics with torpedo-boats in time of peace to be indispensable to their satisfactory performance in time of war, and will be glad, indeed, when one or more "district bases" can be established on our coast.

Doubtless paragraph 14 in Lieutenant Chandler's article is not longer because the ground has been covered by Lieutenants Koester and Jackson in previous articles, but to me it is a question worthy of much consideration.

The importance of a suitable base, where spare parts for all machinery needed in a torpedo-boat, including those for the torpedoes themselves would be available, and where work with machine tools could be done, is great. The idea of a torpedo supply vessel, carrying lighter torpedo craft, seems excellent.

It has been my experience that the crew of a torpedo-boat can be depended upon to execute all repairs incident to service, if the necessary facilities can be furnished.

It seems to be conclusively proven that torpedo-boats and destroyers are not available for offensive warfare upon a coast removed from our own. Certainly but little need be feared from torpedo-boats which have crossed the Atlantic until they have had an excellent opportunity to recuperate both material and personnel.

In this connection something might be said of the absolute necessity of "nursing" torpedo craft. They are necessarily delicate, and to be efficient must be in the best possible condition for their efforts. This "nursing" must come from the highest authority, for it cannot be believed that an officer commanding a torpedo-boat would object to any duty offered his boat in time of war. It is to be expected that such craft may be sacrificed, yet great should be the necessity when they are called to do duty other than that for which they were designed.

In my opinion great care should be exercised concerning the personnel of torpedo-boats. At best life upon such craft is a hardship, and there should be available at the "bases" quarters for those attached to the boats, yet at the same time the boats should be in constant employment.

I believe that the best care can be taken of torpedo-boats by running them frequently at ordinary power, and occasionally at full power.

As for the men employed, the best man aboard a battleship may be quite unfitted for service on board a torpedo-boat, and I am strong in the belief that a man found valuable for torpedo service should be

retained for that service. This applies especially to those connected with the engineer department of torpedo-boats, but I believe in a picked body of men who shall be available for torpedo service only.

Lieutenant J. L. JAYNE, U. S. N.—I think the lecturer deserves to be congratulated for the able manner in which he has handled the subject within the limits he laid down for himself. I agree with him heartily in the idea of dividing our coasts into districts with shore bases for torpedo purposes, and in the idea that "the boats should be continuously exercised in everything pertaining to their war service, keeping men and material tuned up to the highest pitch, while the officers should make themselves familiar with the pilotage of their districts until they can take their boats everywhere under all conditions." Of course this necessitates operations with and against the fleet at times, and I would take advantage of such operations and of the presence of the destroyers (which should accompany the fleet habitually in somewhere near the proportion required under war conditions) to give as many of the officers and men of the fleet as practicable experience, not only of resisting attacks, but of service on the boats in the various duties that they might be called upon to perform in war. A record should be kept of all officers and men who have had any torpedo-boat duty, giving the nature of it, the time employed at it, and the aptitude for it, and also the name of the boat or boats on which it was performed. Such a record might be of great value to the Navy Department or the commander-in-chief in making up crews for new boats or new crews for old boats or in filling vacancies which may occur. It is true that each boat has its peculiarities, and officers and men must become familiar with them before they can get the best results, but men who have had experience with similar boats can gain that familiarity more quickly than those who have not had such experience. For this reason the boats should be as near a standard type in every particular as is consistent with the spirit of progress.

The necessity for training a large percentage of the personnel in torpedo-boat work and keeping a record showing individual aptitude for it was very forcibly brought to my attention at the outbreak of the Spanish-American war by an unhappy experience that I had for the lack of it. As it seems pertinent to this subject, and as it may serve as a warning for the future, I will give a brief account of it here. I was assigned to the command of the Rodgers, fitting out at the Norfolk Navy Yard, when war with Spain was imminent, and one of my first acts after arriving at Norfolk was to appeal to a friend in the Bureau of Navigation for his aid in selecting a good crew for her. I was particularly anxious to secure a man for chief gunner's mate who had had experience with torpedoes and the best men available for machinists and water-tenders. Aside from the well-known intricacy of torpedo-boat machinery, the Rodgers had had several unsuccessful trial trips, sustaining serious damage in one or more of them, which had delayed her completion several months, and was finally accepted when war was

imminent, after a trial much less severe than it would have been at another time, and with this knowledge I felt that I had an excellent reason for requesting picked men in the Steam Engineering Department, especially as I was to have no engineer officer. I may add right here that it is too much to expect of the commanding officer or the one junior officer of a torpedo-boat to act as the engineer officer, even supposing they have the aptitude for that duty, under conditions such as we on the Rodgers had to contend with. The Department sent me a good gunner's mate, but my friend in the Bureau of Navigation wrote me that it was hopeless for him to try to pick machinists and water-tenders. Therefore, I was left to select the crew from the few men available at Norfolk. My two chief machinists were tugboatmen. One of them had great possibilities but lacked experience with such machinery as the Rodgers had and was so subject to seasickness in bad weather as to render him almost useless at such times. I soon had to leave him in a hospital at Key West. The other man was very different and eventually, giving up all hope of his ever being able to fill the place, I exchanged him for a man on the station ship, and I afterwards learned that he was not giving satisfaction at running the engine of a steam launch. In the seaman branch, too, the crew was far from perfect. With such a crew, after a few runs in Chesapeake Bay and a little torpedo practice, we started for Key West, where we eventually arrived after many mishaps. I had anxiously hoped upon arriving there to be able to exchange some of my men for more experienced ones, at least accustomed to blue water, even if they had not had torpedo-boat service. To my great disappointment, I found that this was a very difficult task, as every commanding officer jealously guarded such good men as he had been fortunate enough to get. Some changes were made from time to time, however, and notwithstanding such a great handicap, we succeeded in keeping our boat at sea with the fleet off the north coast of Cuba for two weeks at one time and taking her to Santiago with Gen. Shafter's army; but this was done at the expense of keeping the officers and crew under a tremendous strain (some breaking down under it) and nearly using up the boat.

Now the point I wish to make is that much of this might have been avoided. The two boats of the same class as the Rodgers had been in commission for some months prior to the commissioning of the latter, and during a considerable part of that time had been with the fleet at or near Key West. Had the plan proposed above of giving the men of the fleet experience on the boats acting with it been carried out in this case there might have been a number of them showing aptitude for the duty sufficient to fill the complement of the Rodgers, without taking too many from any one ship; and it seems reasonable to assume that with such a crew much of the trouble might have been avoided.

Even after an experience so full of mishaps as that on the Rodgers, I cannot agree with the lecturer in his opinion "that it would be very difficult to conceive of even destroyers being ordered to accompany our fleet in an expedition against an enemy in his own waters." Perhaps

that experience, together with a knowledge of the experience of some of the other boats, enabled me to see more clearly the possibilities of keeping at sea in large torpedo-boats and destroyers than if it had been less checkered. That the Spaniards made such a poor job with their destroyers does not prove that other destroyers manned by other men cannot accompany a fleet across the Atlantic and there do effective work.

I have not had any experience with liquid fuel, but I believe experiments with it have proven that it can be safely used. If this is true, its use on torpedo craft will greatly simplify torpedo-boat service and render refueling at sea a very simple matter. This of course is a very important consideration in any kind of operations on an enemy's coast. I would like very much to see it applied to a destroyer and her sea-keeping powers demonstrated. The imperfection in the gyroscope that the lecturer mentions is a very serious one, but I expect to see that overcome. Even without the gyroscope destroyers might use their torpedoes effectively if the officers and crews are highly drilled in using them, and they can be used to guard the fleet from the enemy's torpedo-boats even without torpedoes.

In my opinion the following points should receive proper attention to make a success of destroyer service:

1st. The destroyers should be thoroughly tested before being sent on war service.

2nd. They should be manned by men who have an aptitude for the work with considerable experience and not liable to seasickness under the conditions that would exist on board in bad weather.

3d. There should be three or four officers for each destroyer which will be required to keep the sea for a considerable time, one or more of them to thoroughly understand the engines and boilers.

4th. When the boats are operating with the fleet there should be two crews, the relief crew having quarters on board a supply-ship or battleship.

5th. Every boat should be provided with efficient arrangements for towing and being towed, and advantage should be taken of every opportunity, when military and other necessities do not prohibit it, to have the battleships or other large ships tow them and thus relieve the strain on the machinery and personnel. On long passages this would be of great value in preserving the men and boats.

6th. Arrangements should be made for supplying water and liquid fuel, if it is used, from the large ships. This can easily be done while towing.

7th. There should be a large ship provided as a supply and repair ship for the boats, or the large ships should be required to render such assistance when necessary.

8th. Destroyers should not be required to do despatch-boat or other duty foreign to the objects for which they are designed, except in emergencies when it cannot be avoided, and all persons in positions requiring them to direct their movements should be thoroughly aware of the limits of their capabilities and the hardships attached to service on board of them under war conditions.

PROFESSIONAL NOTES.

TELEGRAPH CABLES IN TIME OF WAR.

From the French of J. Depelley. Translated by Lieutenant J. Hood, U. S. N.

The first words exchanged between Europe and America by the trans-Atlantic cable of 1858 were the words of peace, which claimed the neutralization of telegraph lines, the President of the United States claiming in his message of felicitation to Queen Victoria that all civilized nations should spontaneously, with common accord, declare that the electric telegraph should be forever neutral, and that the messages which should be confided to it should be held sacred, even in time of war.

This wish, emitted in the enthusiasm which was born of the first telegraphic communication of human thought between the two continents, was not destined to have a near realization. After forty years the neutralization of cables is not yet recognized. It will, apparently, be a matter of the future; but for the present a submarine telegraph is a powerful instrument of war at the profit of the country which has had the foresight to assure itself of its services.

As soon as the possibility of corresponding at great distances by means of submarine cables had been practically demonstrated, England understood what a commercial and political preponderance would be given to her by the creation of a grand network of cables under her control. Without being discouraged by the onerous failures at the beginning, with a perseverance that one should admire, she has succeeded in creating and developing methodically, without noise, and without rest, a network of submarine telegraph cables which cover to-day the entire world; enclosing it in an immense net of copper, of which London is the center. It is there that the threads of this net converge; and in the whole world not an incident occurs, not a political or commercial fact, of which the news is not first transmitted to London. It is a marvellous agent of information and influence that England has in her hands, an agent so much the more redoubtable that other countries are deprived of it.

A simple examination made of a telegraphic chart shows the grasp of cables belonging to the English companies, and explains certain difficulties of our colonial policy, and throws a little light on facts which have sometimes appeared incomprehensible.

In the direction of North America, ten trans-Atlantic cables connect England with Canada and the United States. Further down towards South America, three other English lines traverse the Atlantic and connect Brazil to Portugal and Spain; and, by their prolongation, to London itself. Other English lines extend from north to south along the Pacific coast. Still others develop all the Antilles and Central America and

complete its first net, which puts the whole of America at only a few seconds from London.

Towards the east, the English lines which extend in that direction, starting from London, quadrupled at certain points, turn Europe at Gibraltar, touch at Malta and at Egypt, on through the Red Sea to Aden.

At Aden is found what one might call the knot of the telegraphic lines, the importance of which is revealed to-day. From there, in fact, starts the first section of the three cables which extend towards India, and which are prolonged by other lines to China, Australia and New Zealand. Another line starts from the same point, extends along the eastern coast of Africa, connecting it to Zanzibar, Mozambique, Delagoa Bay, Natal and the Cape of Good Hope. This grand eastern network has its central point, where all the lines converge, at Aden.

Towards the western coast of Africa, the same English lines which connect London to Portugal and Spain, extend first to Bathurst below Senegal, then, from there, festoon the coast as far as the Cape, where they rejoin those from the eastern coast, enclosing the entire African littoral in a circle of English telegraphs.

There also, it is necessary to remark, are the complete conditions of control with regard to England, in which this network is constructed. In the same manner as by the east, Aden is the point of convergence of all the lines which spread out towards the Indies, China and Australia, and towards Africa as far as the Cape of Good Hope; just the same on the western coast of Africa, a point of convergence of all the lines exists in English territory at Sierra-Leone, and above all, at Bathurst. Through these English stations necessarily passes all the correspondence of the network which extends along the coast as far as the Cape, and which serves the French and Portuguese territories, which, by the way, largely subsidize them.

The importance of the danger of this organization to all that is not English is immediately apparent as soon as one sees the clauses in the contracts which the English government imposes on its telegraph companies. Here are the principles: They suffice to show in a sufficiently strong manner the political views which have guided our neighbors in the so persevering creation of their telegraph network.

"Article 3. The proposed cable shall not employ foreigners at any station. In like manner, the lines will not pass in any office which could be under the control of a foreign government.

"Article 5. The Government of Her Majesty does not make any engagement, or take any responsibility, in anything that regards the cable beyond the payment of the subsidy.

"Article 6. The subsidy will be given during twenty years, and payable at each complete period of twelve months, under the condition that the cable be maintained in a good state and shall have rendered good service, and that the service between the United Kingdom and its colonies and English protectorates shall not be subject to interruption.

"Article 7. The dispatches of the imperial and colonial government shall have priority whenever it is demanded. They shall be transmitted at half-rates, which shall not exceed a sum to be determined.

"Article 9. In case of war, the Government may occupy all stations in all territories which are English or under English protection, and may use the cable by means of its own employees."

Thus in normal times the British government is especially assured of

its despatches, wherever an English telegraph line exists, of a right of precedence which belongs to all despatches which are official according to the international conventions. The reservation of this privilege may appear natural; but, in reality, it has for its end and effect, to give precedence to all English despatches over all official despatches of other countries. It is not necessary to search further for an explanation of the difficulties or delays, so favorable to British interests, which certain telegraph despatches are subject to.

But how much more dangerous is the situation in case of war. The events in the Transvaal should open the eyes of all countries to this menacing peril. Not only the English censorship established at Aden refuses cipher dispatches coming from Marques, from Durban and the Cape, but stops also those which come from Madagascar, as well as from German East Africa. What would it be if, instead of war between England and the Transvaal, the hostilities existed between England and France? It is the question of the rôle of the telegraph cables which is plainly exposed by these facts. What has been this rôle up to the present? What will it be in the future for a country, like France, which has an immense colonial empire to defend, and traditional interests of influence and commerce to sustain in all points of the globe?

Although of an origin very recent, since it goes back scarcely forty years, the telegraphic cables have already mixed themselves so directly in the colonial and maritime international life of all nations that the interest and importance of their existence can no longer be ignored or misunderstood. Notably in time of war they can be the means of action of such weight that one may justly say, that the nation that could alone control a network of submarine telegraphs, to instruct its squadrons of the movements of forces, and the strength of the adversaries, will be the mistress of the sea.

What is passing at this moment for the correspondence that comes from South Africa marks the dangerous dependence in which all countries are placed by the sole fact of the state of war between England and the Transvaal. The events which developed last year in the course of the Spanish-American war, when two maritime powers found themselves at war, furnish in a still more conclusive manner the demonstration of the influence that telegraphic communication will take in a colonial conflict. It was shown, in fact, that a telegraphic war was engaged in between Spain and the United States from the beginning of hostilities; that it followed on parallel lines to the military operations, where one finds for the first time a collection of facts clearly showing the considerable rôle which the submarine telegraphic lines may have to play in a great war.

With a want of foresight, which should be a lesson to other countries, Spain had remained, up to the moment of the declaration of war, without the possession of independent telegraphic lines between Madrid and Havana. She had sustained for several years against the Cuban insurrection, a war openly favored by the Americans, and she had no other means of corresponding with Cuba than by American telegraph lines. Her official despatches and her secret instructions arrived at Havana by the lines which connect New York to Florida, after traversing the United States and the American cables of Florida. This imprudence strikes us to-day, after the events which they have revealed, and appears incomprehensible. However, we must be indulgent to appreciate it; for

other countries, among which France is found, are at the present hour just as improvident, and would be, in regard to their colonial possessions, in the same situation as Spain if war should be declared.

It was only at the moment when hostilities were openly declared against the United States—that is to say, at the eve of interruption of communications by way of the north of Cuba—that Spain undertook with some vigor the search for means of correspondence other and more sure than by American lines. It was far too late. It is not by improvised measures that the organization of a telegraphic service can be made for such a great distance. The other lines which connect with Cuba without touching the United States, come by way of the south, land at Santiago de Cuba at 500 kilometers from Havana. These lines were not prolonged to Havana except by land lines, already in the hands of the insurgents, and by cables submerged along the coast and consequently exposed to be cut. From day to day Havana could thus be isolated from Santiago, and Spain was menaced with having no telegraphic communication with the principal theater of war, where its colonial fortune was menaced.

What a difference in the procedure and in the situation on the side of the United States.

On the day that war was declared one of the first acts of the Government was to apply strict censorship on all telegraphic lines that could reach Cuba. The cables from Florida to Havana, belonging to an American company, were seized and controlled by the military. All the American stations where other lines touch even indirectly in communication with Cuba were equally occupied by military telegraphers. A complete prohibition was applied to the Spanish government despatches, to code and cipher despatches for the West Indies; finally, all written despatches having a tendency hostile to the United States. These first measures, rigorous as they were, appeared insufficient. The Americans wished to completely isolate Cuba by cutting all cables which land on the coast of the island, except the cables from Florida to Havana, which were already in their hands, and of which one raised on board of a ship of war put the squadron in charge of the blockade of Havana in communication with the Federal Government at Washington.* Three ships were rapidly fitted out for cutting cables, the Mangrove, * the Adria and the St. Louis. On the 21st of April, the day of the declaration of war, the Mangrove left Key West for the south of Cuba, with the order to destroy the cables which land at Santiago; that is to say, the English cables from Jamaica and the French cables from Haiti. The Adria and the St. Louis followed several days later, the St. Louis to aid in these operations, in the course of which these ships were always protected by the ironclads. Other ships were equally fitted with tools and special engines for breaking cables. In spite of this display of forces, during several weeks the attempts made were complete failures. The dragging, done at some distance from the shore, remained without result. The Cuban coast presents this peculiarity common to all the Antilles, to descend from a peak to a great depth, in such a manner that at a very short distance from the beach a great depth of water is found. Dragging for cables is, therefore, difficult if they are not searched for at the shore ends. It was that, after numerous fruitless efforts, the Americans re-

* N. B.—Errors of fact of the writer.

solved to do, and even under these conditions they only obtained success by acts of audacity and by running very serious dangers.

On the 18th of May, the St. Louis, wishing to make a decisive effort to cut, in front of Santiago, the cables from Jamaica which it had uselessly hunted for at sea, commenced to drag for it at seven miles from the fire of Santiago. Little by little, not finding the cable, it approached to within a mile of the entrance of the harbor. At this point it grappled a cable, but at the same moment the fire of the Spanish forts began, and the operation became dangerous; the work was hastened; the cable was hoisted on board; it was cut and the ends hastily thrown into the sea. The St. Louis retired, well convinced that it had interrupted communications with Jamaica. The news was given to all the American press. It was a veritable exploit! It was announced at the same time that the French cable from Santiago had been cut near its landing on Haiti, and that, consequently, Cuba was completely isolated.

And the cable raised was only a piece of old cable abandoned in an ancient repair! This old cable, sunk under the sea for many years, hardly expected to see the light of day under such glorious circumstances. None of the telegraphic lines from Santiago had in reality been injured. As to the French cable, it was never touched on the Haitian coast.

Having recognized the negative results of the expedition attempted at Santiago, the Americans did not acknowledge themselves beaten. They wished to cut the cables which connected Santiago to Havana, in order to isolate General Blanco from all communication by the south, as he was already without communication by the north. These cables, which are developed along the south coast of Cuba, have several landing places. At one of these, Cienfuegos, an attempt at cable-cutting was made under conditions particularly daring.

Cienfuegos is situated within a land-locked bay which one enters by a narrow entrance three miles long. At the entrance of this canal there is a lighthouse on a hill 300 feet high, at the bottom of which runs a narrow sand beach. At a small distance from the lighthouse is erected the cable hut of the cable lines, visible from very far at sea. The American forces united before this point were composed of four ships of war. Two steam launches and two cutters were dropped into the water. Each of the cutters had a crew of sixteen armed men and was supplied with tools for cutting cables. The steam launches were to tow the cutters up to the shore, while the ships, placed at about a mile distance, would bombard the lighthouse and the cable hut.

The operation began at daybreak and was carried out rapidly. While the ships directed a very lively fire on the beach, the boats approached the landing within a distance of 100 feet from the cable hut, already nearly destroyed. The depth of the water was too great to grapple for the cables. To the great surprise of the Americans, the Spaniards did not open fire. The cutters approached to within a few meters of the shore till a depth of scarcely 20 feet was reached, where they grappled first the cable going towards the east in the direction of Santiago. It required 30 strong men from the two cutters to hoist the cable aboard. It was a shore-end cable, thick as the arm of a man, and the weight to be lifted out of the water seemed to be several tons. After putting it on board, it could be cut.

One of the ends, that which went to the cable hut, was thrown into the water. The other was hoisted for a length of about 150 feet, with the

intention of carrying it on board of one of the ships to try to communicate with Santiago; but the weight was such that the boat nearly foundered, and it was necessary to rapidly make a new cut in order to throw the cable into the sea, keeping on about 100 feet.

All these operations were accomplished without the Spaniards having seriously opened fire on the Americans.

The same work was immediately undertaken on the other cable going in the direction of Havana. It was only about 60 feet from the shore that the cable was grappled; while the ships redoubled their fire, the shells being fired over the heads of the men working in the boats. The position, however, became dangerous, for the Spaniards commenced to fire vigorously on the Americans. Shot literally rained about the boats, and already several men were wounded. The cable was cut in the same manner as the other and thrown into the sea. In raising it in this small depth a third cable had been seen. The Americans wished to cut this also, and they had already put the grapples into the water to hook it, when the fire of the Spaniards became so lively that the operation had to be abandoned. The cutters were towed to the ships, having lost several men. The ships themselves had been seriously tried by the fire of the Spaniards, since the captain of one of them, the Nashville, had been wounded. But, by happy chance, the Americans had truly cut the two cables which connected Cienfuegos. The third cable which they had not been able to touch simply connected between the hut and Cienfuegos, and had no importance whatever.

The result of this dangerous operation was of capital value. The cutting of the cables of Cienfuegos completely isolated Havana, and completely deprived General Blanco of means of communication with Admiral Cervera, enclosed at this time in the harbor of Santiago.

But in spite of all these efforts, Santiago still remained in telegraphic communication with the outside world by the English cables from Jamaica and by the French cables from Haiti. It was not until the 7th of June that the French cable was finally cut. The news of the interruption was not incorrect this time. The cutting this time had also taken place near the landing end, and in shallow water, and after the bombardment of the coast the Americans had chased the Spaniards into the interior. The Americans landed troops, and it was at this time they commenced to occupy the environs of Santiago.

As to the English cable from Jamaica, it was landed in the mouth of Santiago harbor under the protection of the Spanish fort. It was not cut in spite of several efforts, of which the first produced the amusing error that has been related. All the draggings made in the open sea were made without any result, and as the landing could not be approached, it was impossible to cut the communication, which did not cease to act until the end of hostilities. It appears, however, to have been of very little utility to the Spaniards, and to have annoyed the Americans very little, who had succeeded in organizing under the direction of a man of great merit, Brig.-Gen. A. W. Greely, a remarkable service of surveillance on all the telegraph lines which could reach Cuba. This service was incontestably one of the features of the success of the Americans, who were powerfully aided by the confusion and discouragement thrown among their adversaries, thanks to the absence of news and exact knowledge.

In any case, a lesson is taught in a striking manner from this collec-

tion of facts; that is, that contrary to what has been heretofore supposed, the cutting of cables by improvised methods offers very great difficulties. The Americans brought to the work great resources and a considerable force, against a country poorly defended, and succeeded only in cutting some lines, at the expense of very great danger.

Just as easy as it is for a vessel, installed and provided with tools, and with a trained personnel, to pick up and repair a cable, whose position is exactly known, just so difficult is it and little practicable in time of war, to search for cables away from their landing places. It is only at these places that it is possible to arrive at any results; and the recital just made shows how dangerous these operations have been.

It seems, then, that the best plan of defense would be to keep secret the tracks of the cable laid, and to conceal the landing places, instead of making them conspicuous at a great distance by towers and beacons, as is done now. It seems also that it would be easy to select the landing sights in a manner to organize a defense there, which would render the approach dangerous in time of war.

Another lesson shown by the same facts; that is, the interest that telegraphic communications present in time of war. The isolation of Cuba from Spain and from other countries was the aim towards which the efforts of the Americans were first directed in the Spanish-American war. Their first movements were made for the purpose of cutting cables; they were not entirely successful, since the cables from Jamaica remained intact. But who can say that had the Spaniards been better informed of the progress of their own operations, and of the movements of the American forces, they would not have been able to make a longer resistance?

The rôle of the cable is accentuated, then, in a manner which should engross the attention of all nations. A nation with fleets to move and colonies to defend should possess, if it wishes to keep its rank, "coaling stations and telegraph cables." This is an axiom to-day. A brief outline of the progress made by this idea among maritime and colonial powers, our neighbors and our competitors, will, perhaps, be of some interest.

If in the midst of the weighty colonial problems which trouble a part of Europe, any country ought to be safe from the anxieties which the rôle of telegraphic cables can create in time of war, assuredly England is that country. We have seen that she possesses, through her cable companies, the largest part of the telegraphic network which furrows the seas; that she has in her hands, with this network of more than 155,350 miles, a means of real dominion over the entire world.

Nevertheless, she is not yet tranquil, because certain of her cables touch in some points of their line on foreign territory. She wishes—and it is well known what the English will is—a network of cables making their landings exclusively on British territory. It is a new expansion of her imperialism, which this time she wishes to extend to the depths of the ocean. One might believe it some odd fancy, if the idea of "imperial" cables was not effectually sustained in England by personages of the first rank, and if projects had not been formed which are in process of realization.

The English government decided some months ago that a subsidy of 500,000 francs should be added by the metropolis to the subsidies, reaching 1,000,000 given by Canada and Australia for the establishment of

a trans-Pacific cable, starting from Vancouver, reaching Australia, going by way of Fanning and Norfolk Islands, rocks almost deserted, lost in the Pacific Ocean, but *English* rocks. This cable is destined to prolong by a line exclusively British the English cables of the north Atlantic and the Canadian lines. The technical study for the line is made. The execution will take eighteen months. Very recently, on the 19th of October last, à propos of this subject, Mr. Chamberlin, exclaimed to the House of Commons, that the direction of the new trans-Pacific line would be entrusted to a board of eight members, whose sittings will be held in London. The government will be represented in this board by three members, one the president; Canada by two, Australia and New Zealand by three. Canada has already designated Lord Aberdeen and Lord Strathmore. The Australian colonies and New Zealand will be represented by the General Agents of New South Wales, Victoria and New Zealand, and negotiations are going on between the Chancellor of the Exchequer and the Postmaster-General to select the representatives of the capital. This project, endowed, as one sees, with a patronage quite governmental, forms one part of the new imperial cable, which is to make a tour of the world.

The other part has gone beyond the state of a simple project, and has already begun, which consists in the establishment of a new line starting from the coast of England, touching at Gibraltar, at Bathurst, at Ascension and St. Helena, and finally at the Cape of Good Hope. From the Cape it goes to Mauritius, where there is a coal depot, and where they wish also to form a great telegraphic center. Finally from Mauritius, a cable will be laid to Australia and will close the circle with which they wish to envelop the world. The first section of this cable has just been sunk and opened to service between the Cape and the Island of Ascension, and in a few weeks it will be extended to Bathurst.

The outlay for this second scheme, already so far advanced, will be some 125,000,000 francs, but that does not frighten our neighbors. One of the London papers says on this subject: "The sum of 125,000,000 francs demanded for this project would suffice to construct five battleships, but it must be understood that such a network of lines will offer the advantage of making every ship of war five times more powerful and more useful than it is at present." It must be supposed that after the establishment of this great line, England will see herself somewhat reassured and have a moment of tranquillity. But what a lesson for France this is, seeing that the importance of the rôle of cables in times of war disturbs even the country which possesses four-fifths of the telegraphic network in existence to-day.

Passing to the United States, who have just found out in practical experience with Spain the use which one could make of cables in time of war, it can be said that to-day the same desire to assure oneself of the possession of these means of attack and defense, and the manner in which this desire is manifest, one recognizes the common sense and forethought of these people for whom colonial politics is yet quite new. There is in fact a very striking lesson in the project presented before Congress since the 10th of February, 1899, for the laying of a trans-Pacific cable to connect the Philippines with the United States, even before the occupation had been made effective.

Taking action at once, the American government has already caused to be made, even before the action of Congress, a survey by a war

vessel for the location of the route of this new cable. This work is already finished.

In their debut in colonial politics the United States shows by this project the far-sighted comprehension of those necessities which have for so long a time escaped us in France. We have had colonies for centuries. For 25 years we have conquered a vast colonial empire, and the greater part of our possessions are not yet even connected telegraphically to the mother country except by the most precarious means.

Another great nation is also preparing to take a place among the colonizing nations by the laying of a submarine telegraphic cable. Germany herself, notwithstanding her geographical situation, which gives her seacoast on the North Sea only, wishes to have cables which may be independent, and assure to her the security of her telegraphic correspondence, with the United States at least. She is about to carry out a project upon which our attention might well be directed for a moment.* It is in effect of French origin and conception. It is a project which has been studied in France under the name of "Project of the Azores," and which has been abandoned. It has been taken up again to-day and is going to be realized from point to point by Germany. It consists in the establishment of new lines which will connect Germany to the Azore Archipelago, and the Azores to North America, and creating in the middle of the Atlantic, the telegraphic center that France should have herself established several years ago.

We have remarked, without doubt, the information published sometime ago by the American journals, announcing that Germany had obtained the authorization to land a cable on the coast of the United States. Equally we have read the friendly despatches which have been exchanged on this occasion between the German Emperor and President McKinley. Hence, this authorization and this exchange of telegrams had regard to this project. In 18 months, or two years at most, a trans-Atlantic cable will be laid between Germany and America, passing by the Azores. It will be established by a German company, with the support of the government, and the enterprise is placed, from the present moment, under the highest and most official of patronages. All these facts will show, if that is still necessary, the importance given in all maritime countries to the question of telegraphic cables.

It would be unjust if, after having indicated what other countries are doing, or wished to do, we passed over in silence what has been realized in France, to commence at least to guarantee our country against certain dangers.

Three years ago there only existed, as a French telegraphic enterprise, a little network of cables joining several of the Antilles among themselves and South America. Since then a single trans-Atlantic line between Brest and the United States without an assured end in America, depending consequently on the English and American companies, and almost entirely served by them.

In the course of these three last years an interesting effort has been made to break the circle of competing hostilities which have paralized, up to the present, all French enterprises of submarine telegraph.

A first cable has been established between Haiti and North America to join the lines of the Antilles to the trans-Atlantic cable which has just been landed at Brest. This trans-Atlantic cable has itself been dupli-

* N. B.—This project has already been completed.

cated by a new submarine line which connects Brest directly to New York. The new line is the longest which exists at present. It is more than 6000 kilometers; its construction and its laying have presented exceptional difficulties, and, for its beginning, French industry has accomplished a daring work, to which its competitors themselves render justice.

To-day a French telegraphic system works, with the resources of its own traffic, with the development of the lines which permitted it to reach North America, all the Antilles, and South America as far as Brazil. This telegraphic system comprises already 23,500 kilometers of cables. It reaches the third rank in importance and extent of line, and alone, at the present time, it is being developed in the face of the enormous monopoly of the English companies. Its point of attachment is Brest. Its employees and its direction are French, and it brings to correspondence with our American possessions the guarantees and the securities that we claim for all our colonial possessions.

Unhappily, it is not the same for Africa, for the east and the extreme east. Towards these regions our correspondence can be transmitted by French lines that only reach Marseilles for the east, or to Algiers or Oran for Africa. In this direction nothing has yet been undertaken and we have all to do.

We have seen that an active movement of ideas and projects is produced in all great maritime countries in favor of the creation of nets of cables. The events of the Spanish-American war have given a vigorous impulse to this movement. The more recent incidents of the war with the Transvaal mark more distinctly the point of danger in allowing to exist the British monopoly which weighs on all nations. France especially finds herself menaced and crippled if circumstances should lead her to sustain a war against England. The single idea that it will be impossible to correspond with her colonies and with her squadrons in the east and in Africa awakens a grave inquietude.

By what means can one modify this state of things? What measures is it possible to take? These questions appear to-day of a most pressing force. They have sprung suddenly to the front in the opinion which, surprised by the discovery of a new insufficiency in our means of defense, it is not far from accusing our public powers of want of foresight.

It is useless to take up again the history of efforts made during the last twenty years to produce a system of French telegraph. Except for the creation of lines which connect France to the United States and its American possessions, they have all lamentably failed, and furnish only one more proof of our ignorance to our own interests.

Some small cables have, however, been laid between Majunga and Mozambique for Madagascar, between Noumea and Australian coast for New Caledonia, between Saigon and Haiphong for Tonkin, between the Canaries and St. Louis for Senegal; finally between Obock and Perim Island for our possessions of the Red Sea. These small cables, of which the most important are exploited by the English companies—that we subsidized—all join the English lines and are in reality only simple annexes. We should all the more point out this situation since it is the result of a mistake which has, up to the present, dominated what we are pleased to call our policy of cables, and which still haunts certain minds. Simply to put off till to-morrow certain inevitable charges on the budget, if one has any care for the future of the country,

they have preferred half-measures, so common in France, of placing at the four quarters of the globe little ends of cables to connect certain of our colonies to the general telegraphic network. They forget that this network belongs in fact to the English companies, to whom they have intrusted even the laying and the working of certain of these cables. These, happy for the gift, receive the French subsidies and draw all the benefit of the establishment of a telegraph in the new countries which we colonize. These bits of cables, distant one from the other, without connection between themselves, are, however, a heavy charge, and give no security to our correspondence, and leaves us always tributary to the English system.

It is then an erroneous and dangerous conception of the question of cables that it consists in creating little local lines for our colonies. The true conception, that which alone can lead to practical solution, is the creation of telegraphic systems grouping our colonial possessions by regions, and connecting them to the metropolis by cables independent of the English lines. This is the only means of having cable lines which can become productive at a given moment, and constructing them in such a manner that the telegraphic traffic created by the new line shall not be turned aside for the benefit of the English lines. It is the passage of this correspondence between our colonies and France that will furnish the enumeration of the new enterprise. It was foolish to abandon it to a rival enterprise. It is also on this condition alone that we will avoid English combination, and that we will have in our own hands an agent of information and of defense which is indispensible to us, above all in a moment when we have so many interests to watch in China, Siam, Madagascar, Morocco and all of Western Africa.

It seems, moreover, that we should in the present circumstances and for the future, look at the question of cables with a courageous broadness if we wish to solve it. There exists to-day a chasm in the armament of France for the defense of its interests in the countries beyond the sea; a chasm which it is necessary to close without loss of time, if we wish to be ready for certain menacing eventualities.

It is, hence, necessary to resolve to proceed by measures united, vigorous and rapid as we have done when the lacks and the weaknesses have been proved in our armaments, in the organization of our lines of railroads, and in the construction of our ships. It is at this price that we can regain the time so uselessly lost for several years. The study and the choice of a plan of which the execution will be followed with a continuity of views and of perseverance of which the English give us every day example, will be easy at the present time, for the lessons of the Spanish-American war and of the war in the Transvaal appear to have disposed the government, and public opinion itself, to give its attention and solicitude to this side.

Neither is it a question of the government engaging directly in the expenses of establishing these networks and of burdening the budget with the whole expenses. The intervention of private initiative could furnish in France, as it has in England, the means to realize these enterprises.

Only, it should be well understood, that new telegraphic networks, having no longer the choice of rich countries to serve, must be, at first, and for several years, political instruments, established with a view of defending an interest of general order for the country; they will become

instruments of manufacture and of commerce, productive of sufficient resources to be self-supporting, only progressively, in proportion to the development of our colonies, and therefore of telegraphic traffic. Only after some years will they be able to do without the co-operation of the government. This co-operation, whether it is given under the form of subsidies as in England, or as simple guarantees, should be furnished in the beginning, under conditions liberal enough to at least secure the capital invested. The political interest whose importance can no longer be disputed would amply justify this. This interest is of the same nature as that which caused the grant of postal subsidies fifty years ago. To-day the telegraph completes the mail, precedes it in all distant relations; it is a means of indisputable influence, quite as much as its worthy predecessor, and may be called to play a rôle, active and useful, in the solution of questions which interest our future and our defense in countries beyond the sea. Why not now admit the idea of a liberal co-operation of the state in favor of telegraphic networks for the same reasons which made us inscribe the postal subsidies to the budget and keep them there?

To reassure timid minds, whom the disturbances of the equilibrium of our finances may trouble, let us hasten to say that the share of the state would be probably very far from reaching the figure of the subsidies now attributed to the postal service. More than that, in place of being permanent as the postal changes, they could be made reducible, and to disappear at the end of a fixed time, when, by the normal development of telegraphic communications, the network would have required assured resources of existence. It is our good fortune that these cable lines, demanded for our defense, correspond to economical and commercial needs of such importance that these needs alone would be sufficient in any country less timid than ours, to provoke their creation. The submarine telegraph is a new instrument of labor and progress, which enters into international life, and its application may have unlimited development. It is scarcely forty years ago since the first trans-Atlantic cable was open to service, and last year more than thirty millions of words were exchanged between Europe and North America. It is impossible to appreciate what the development may be in the next forty years, since its use increases every day. It will possibly reach eighty or one hundred million of words between the two continents. France should make herself ready to take her legitimate share of this wonderful expansion of telegraphy. Simply from an economical point of view, it is a new domain opening and inviting French activity, a domain which has already been explored. Great telegraphic enterprises have been established in other countries; in England, to radiate over the entire world and to control it; in Denmark, to serve the north of Europe and Asia. All have had laborious beginnings; yet to-day they have reached a state of powerful prosperity, shown by their annual receipts, exceeding $22,000,000 for the enterprises which have reached a normal development.

The geographical position of France, at the extremity of continental Europe, opposite America, with the seacoasts both on the Atlantic and the Mediterranean, lends itself admirably to the creation of these enterprises. If we had a little boldness and perseverance we might have had several years ago cables joining us with our own colonies, as well as several trans-Atlantic cables, and the grand center of telegraphic exchanges between Europe and the rest of the world might perhaps have been Paris instead of London. Would there not be besides an interest

in the rôle for France to take in the movement, which is manifest to-day in all countries, to free themselves from the telegraphic monopoly of England? To destroy this monopoly, to suppress the danger of it, it is sufficient that a non-English network be created to reach all the countries where Europe possesses interests.

It might perhaps be an act of wise and far-sighted policy to associate in this enterprise, in terms reconcilable with the needs of our defense, other countries, unable to have cables of their own, but wishing to escape from the dependence in which they find themselves. The international character thus given to the new network would be its best safeguard in time of war, and if in the future these networks multiply and form in their turn a new web at the bottom of the sea, inoffensive and peaceable, the most decisive step will have been taken towards the neutralization of cables.

Assuredly here is a work for emancipation and of progress of which France ought to take the initiative, and where she would find herself faithful to her ancient and historical traditions.

THE DEVELOPMENT OF GERMAN NAVAL CONSTRUCTION.

From International Revue, September, 1900. Translated by Lieutenant H. J. Ziegemeier, U. S. N.

In all spheres of industrial activity there are revolutionary changes, in technical as well as in the economical phenomena and the condition of affairs connected therewith; but in no branch is this assertion more justified than in the methods of communication on land and sea and the different industries depending thereon.

Whilst the railroads have revolutionized the communications on land, so also has the evolution of trans-oceanic communications between different countries been put under the dominion of the steamer. The utilization of steam as a motive power created new means of communication, which gave an unheard of development to the relation between countries, which in turn gave rise to technical inventions more and more perfected. This change and perfection in the means of communication at sea, merchant and passenger steamers, gave rise to a great impetus, especially in Germany, to the industry in general, but especially in the shipbuilding yards and naval dockyards as well as in the shipping industry and in the equipment of vessels.

Towards the end of the eighteenth and at the close of the nineteenth century the principal seat of the shipping industry was located on the Baltic Sea. Not only was there a flourishing maritime commerce during these centuries, but even during the Hanseatic times had the shipbuilding industry been installed. Passing over wretched politics which regulated naval construction, it took a considerable development, thanks to the immense quantity of timber in the neighboring countries; and, as far back as the eighteenth and nineteenth century, the prohibition of exporting ships having been abolished and the construction stimulated more than ever by the payment of bounties, the shipbuilders received foreign orders of some importance.

The stagnation of an economical existence in Germany towards the

close of the eighteenth century and the formidable growth of error, practiced on marine construction corporations, aided by continental blockades, succeeded in severely shaking and almost in destroying this industry. And, when after the reforms in the interior of the country succeeding the wars for freedom, navigation received a new impetus, creating a great demand for ships, the elasticity of this industry and the technical capacity which was in part checked showed itself scarcely able to meet the new exigencies.

While the shipowners of the Baltic Sea were left to carry on a sphere of activity by the navigation of the North Sea, especially since the beginning of emigration, and the more frequent trans-Atlantic voyages, the naval shipyards of the Baltic, which at other times had provided foreigners with their productions, were not able to keep up with this new development.

Again the new sensations coming from England in the shape of iron-built ships it was affirmed with obstinacy: "Iron will not float." Moreover, what could be done with this antique method of building wooden ships, which the son had inherited from his father, who in turn had inherited it from his father, against these new mysterious constructions, requiring scientific calculations as to displacement of water, stability, etc. —and after the introduction of steam as a motive power—the locating of heavy pieces of machinery, of boilers, and the fitting up of immense spaces for coal-bunkers. In Germany there existed no means of preparation for this technical supervision. The school of naval construction, founded in 1830, at Grabow, near Stettin, had no capable professors; it was not until 1861, when a division of naval construction was added to the Royal Industrial Institution at Berlin, that Germany acquired a school for scientifically studying this new problem; a school as had existed for a generation in England, France and Denmark. It is not astonishing, then, that whilst Germany had to content herself in utilising for the marine construction of iron, the experiences gained in the building of wooden ships, other countries, especially England, had made immense progress, and this owing to the natural resources of coal and iron, which were there side by side, and to the existence of one of the oldest iron industries, with a capacity of production almost without competition, with immense capital and a capacity of production that Germany attained with difficulty after a lapse of time.

Whilst England in 1843 had constructed the Great Britain, and in 1852 the Great Eastern—the new world wonder—the German shipyards had only built a side-wheel steamer for service on the Elbe River, and it was not until 1852 that the shipyard of Furchtenicht and Brock at Bredow, later the "Stettiner Vulkan," launched their first iron ship. It was only little by little that the other shipbuilding firms on the Oder and on the Vistula followed this example; for the fittings of a shipyard required space at that time considered immense, shops complete for the construction of ships, machinery, boilers, foundries, pattern shops, forges and repair shops, and above all, builders scientifically and commercially perfect and with capital.

An old sailing ship from 400 to 500 tons had only cost about 50,000 marks, of which the hull cost about 60 per cent and the equipment 40 per cent, including sails, cordage and English anchors; but modern ships of corresponding dimensions would cost from one to several million marks, whilst to-day the price of the new trans-Atlantic liners reaches

10, 12, and even 14 million marks, of which the hull costs about 4/10, the engines and boilers 5/10 and the equipment only 1/10.

From what precedes it is clearly seen that it was not until after 1873 that the German industry took root and prospered. Towards this time it received a great impulse by the demands for men-of-war. This proved in a way the maxim of Admiral Storch: "Without German naval construction there can be no German navy." Although already in 1869 the imperial shipyards at Kiel and Wilhelmshaven had undertaken the construction of ironclads, a number of private shipyards, "Vulkan" at Stettin, Schichau at Elbing, to which was added later "The Germania," showed an extraordinary activity in the construction of men-of-war; the good reputation of their products soon drew to the German shipyards numerous orders from foreign navies, the first of these being China. Little by little German naval construction learned to conquer all difficulties, so that in 1875 the factories at Dillingen were undertaking with success the manufacture of steel plates, so as to surpass even England in the production of mild steel. It was then also that that body of practical and theoretical engineers was formed which at the end of the century has carried German naval construction to the highest state of perfection.

This development made giant strides. German proprietors of merchantmen, who up to the present had been a little cautious and hesitating, having for a long time been in the habit of having their ships built in England, Scotland, on the Clyde, on the Tyne or on the Baltic, seeing these productions, no longer hesitated in giving their orders to German shipbuilders; especially in 1879, when the duty on all shipbuilding material was abolished, thus putting the German yards in a better state to compete in price with the English ones.

In 1882 the Hamburg-American Line ordered from "Vulkan" and from "Reicherstiegwerft" the large steamers Rugia and Rhaetia, and the "North German Lloyd Co." agreed hereafter to use only German-built vessels in their voyages in order to obtain the government subsidies.

"Vulkan," who had at the same time an order for six similar steamers, was better fitted for working on a colossal scale, having overcome the losses at first sustained, but losses which served as a lesson, and which enabled them in the future to fulfill all demands. In 1888 the first large trans-Atlantic liner, Augusta Victoria, was launched, followed soon after by the Kaiser Wilhelm der Grosse, thus being able to boast of a production which did not even have its equal in England. The construction and lengthening of three steamers to be subsidized, executed by the firm of Blohm and Voss furnished another proof that German naval construction had likewise reached perfection in the merchant marine construction.

The construction of men-of-war had made equally rapid progress, thanks to the orders for four armorclads of the Brandenburg type and the large cruiser Kaiserin Augusta. The nickel-steel plates produced by Krupp in 1894 furnished an armament that no industry outside of Germany could produce. In the construction of torpedo-boats the firm of Schichau reached a high degree of perfection. The torpedo-boat chasers constructed in 1895 for the Chinese navy attained a speed of 35.2 knots, fulfilling all anticipations.

But it was on the 10th of January, 1900, that the German marine

celebrated its greatest triumph, and where it entered boldly into a new epoch; on that day the steamer Deutschland was launched; the dimensions of this vessel are: displacement, 23,000 tons; length, 202 meters. This vessel has 33,000 horse-power and is one of the fastest in the world, and capable of carrying 1320 cabin passengers.

The industrial activity has increased likewise. Owing to the immense developments in the shipyards and dry docks, Germany, which as late as 1890 was getting three-fifths of her ships from England, is in condition to build nearly all the ships for which she has need. In 1898 the importation from foreign markets had fallen off one-third. More than 16 per cent of all the new constructions were for foreign orders.

The German shipyards during 1899 furnished in all 468 ships complete, aggregating a total of 250,000 tons; one-eighth more than in 1898, without counting 250,000 tons in different stages of completion. Among these ships completed, 87 were of 500 tons and over, and 87 per cent of all being steamers. For the navy there were only 5 of this number, 6 per cent as against 18 per cent for the preceding year.

In 10 years the output of German naval construction has doubled, being in 1889, 80,000 tons steamers and 20,000 tons sailing ships.

The consumption of iron has likewise increased from 45,000 tons in 1890 to 85,500 tons in 1899.

The proportion of German shipbuilding to the entire world's output has a little more than doubled itself, being 13 per cent to-day, whilst England's proportion has fallen from 81 per cent to 75 per cent.

There are employed to-day in the German shipyards about 38,000 workmen, and adding to this number those working on the necessary accessories—steel, iron, wood, etc.—the number is about 50,000.

Outside of the three imperial shipyards there are 39 large plants for the construction of vessels, 14 stock companies and 25 private shipyards, representing an actual capital of 110 millions. Five of these shipyards are equipped for the construction of first-class men-of-war, 9 can build cruisers, 4 or 5 are in condition to undertake the construction of large trans-Atlantic liners, and 14 can construct first-class passenger ships.

Thanks to its naval construction industry, Germany is able to furnish all the means of transportation that her maritime interests may require, and this not only in a very able way, but also in a most enterprising manner, which can resist the tempests that a coming generation could stir up.

In English naval construction, on the contrary, there has been a remarkable decrease during the last three months. Whilst the total tonnage of ships launched in 1899 was 1,414,000, giving a mean of 360,000 tons for three months, during the first three months of 1900 only 245,000 tons were launched. At the beginning of the year there were 1,260,000 tons in process of construction as against 1,385,000 tons at the beginning of 1899.

The English press actually tried to find the cause of this remarkable phenomena. One particular English journal believes that the actual price of new constructions is too high to give the necessary profits to the shipowners.

To this must be added the advance in cost of coal. Nearly all the steamship companies are complaining at the price demanded for coal, and this circumstance very often offsets the other improvements produced in commercial relations.

It is quite possible that these circumstances have contributed to diminish the desire of English shipowners of having any more ships built than the actual need at present requires; but it can well be believed that there may be other reasons. Besides these unfavorable conjectures about the times, the competition which increases from year to year, and in which, as we have seen above, Germany takes so active and brilliant a part, has contributed to this decrease, which the United Kingdom has had to take notice of during the last three months.

REPORT OF THE CHIEF OF THE BUREAU OF ORDNANCE.

The report of Rear-Admiral O'Neil, Chief of the Bureau of Ordnance, states that satisfactory progress has been made in the manufacture of the new long-caliber guns with which our latest battleships and cruisers are being armed; it also shows that the important work of converting the old slow-firing weapons to rapid-fire guns is being carried through as fast as the capacity of the gun shop at Washington will allow.

During the year the last of the 13-inch guns ordered, making thirty-four in all of that caliber, has been completed, while of the twenty 12-inch guns of the new 40-caliber pattern ordered for the ships of the Maine and Arkansas class, one has been tested at the proving-grounds and has given admirable results. The test showed that this weapon is the most powerful of its type in the world, for under a powder-chamber pressure of only 16½ tons, a velocity of 2854 feet per second was developed, with an equivalent muzzle energy of 47,994 foot-tons. The power of this gun is shown by comparison with the 12-inch gun of the Iowa, which with brown powder has a muzzle velocity of 2100 foot-seconds and a muzzle energy of only 26,000 foot-tons; or with the 13-inch gun of the Kearsarge, which with smokeless powder develops an energy of some 2000 or 3000 foot-tons less than the new weapon. Our new ships of the Maine and all later types will unquestionably be armed with the most powerful 12-inch rifle in the world.

EIGHT-INCH GUN.—The mention in the report of the 8-inch nickel-steel gun, 35 calibers long, which has been fitted with a new conical breech mechanism, calls to mind the late lamented Lieutenant F. J. Haeseler, who, like the late Lieutenant Dashiell, was one of the most promising of our young ordnance officers. The breech mechanism of the 8-inch gun mentioned was designed by the former officer. The threads of the plug are continuous and wind about a conical breech block. There are no slotted-out spaces, as in the cylindrical block, and its conical form enables the block to be swung on its hinge immediately into position, a single pull of the lever closing the block, turning the plug 225°, and engaging the thread throughout its whole length. Remarkable results for velocity of fire were shown by this gun at its trial. Beginning with the gun loaded, a rate of fire was obtained of six unaimed shots per minute.

SEVEN-INCH GUN.—We note with satisfaction that a set of forgings for a 7-inch experimental gun of 45 calibers has been delivered at the naval gun factory. The call for a gun intermediate in weight and power between the 8-inch and the 6-inch is occasioned by the wonderful improvement in armor due to the introduction of the Krupp process.

Time was when the 6-inch gun was more than a match for the light armor carried by the cruiser class; but to-day it is questionable whether the 6-inch shell, even when fired from guns of the highest velocity, will have, at the ordinary fighting ranges, sufficient penetrative power to get through the Krupp plates of the modern cruiser. The 7-inch or 7½-inch gun combines something of the penetrative power of the 8-inch with much of the handiness of the 6-inch weapon, and we confidently look to see it adopted as one of the standard guns of the navy.

SIX-INCH GUNS.—An experimental 6-inch gun of 46 calibers has been tested, and with a chamber pressure of half a ton more than the 12-inch gun, or 17 tons to the inch, has developed a muzzle velocity of over 3000 feet per second. The new guns of the battleship Maine and all later ships are to be 50 calibers long, and this increased length will no doubt enable them to secure the same velocity with a chamber pressure considerably below the specified regulation pressure. These results are, if anything, more creditable than those achieved with the 12-inch gun; for the muzzle energy corresponding to 3000 foot-seconds is over 6000 foot-tons. The muzzle energy of our early 6-inch guns is only 2773 foot-tons, so that the introduction of its own special powder and improved methods of construction have enabled our Ordnance Bureau to more than double the striking energy of this caliber of weapon.

Good progress has been made with the new 50-caliber guns of 5-inch, 4-inch and 3-inch caliber, and the present indications are that the armament of the many new vessels under construction will keep pace with the progress of the ships themselves.

A most valuable work of reconstruction, of which but little is known, is the task of converting the old slow-firing guns of the earlier ships of our navy to rapid-fire guns, thereby enormously increasing their efficiency. During the year twenty-five 6-inch, 30 caliber guns have been converted, making a total of eighty of this class which have been thus improved, while four 8-inch, 30 caliber guns which were removed from the Chicago to make way for a more modern type have been fitted with new and improved breech mechanism. The time is approaching when the batteries of every ship in the navy will be of the rapid-fire type.

As was recently mentioned in these columns, the Bureau has been successful in securing satisfactory contracts for the armor required for the three battleships of the Maine class, the five battleships of the Pennsylvania and Virginia classes, the six armored cruisers of the West Virginia class and for the three protected cruisers of the Milwaukee class. It is highly gratifying to learn from the report before us that the ballistic qualities of the Krupp plates which have been made by the Carnegie and Bethlehem companies for Russia show that the armor-makers of this country are capable of reaching the highest standard in the manufacture of face-hardened armor.—*Scientific American*, Dec. 22, 1900.

THE BRITISH NAVY.

On Tuesday the official list of the ships ordered to be commenced was published. It represents an addition of two battleships, six armored cruisers, two second-class cruisers, and a couple of sloops, to the British navy. The battleships are the Queen, to be built at Devonport; and the Prince of Wales, at Chatham. The armored cruisers are the Cornwall,

to be built at Pembroke; the Suffolk, at Portsmouth. Orders for the remaining four have been given to private firms. The Berwick will be built by Beardmore & Co., Limited; the Cumberland, by the London & Glasgow Shipbuilding Company, Limited; the Donegal, by the Fairfield Shipbuilding Company, Limited; and the Lancaster, by Armstrong, Mitchell & Co., Limited. The two second-class cruisers will be built in government yards—the Challenger at Chatham and the Encounter at Devonport. The Odin and Merlin sloops will be built at Sheerness. In another page will be found detailed information about the contracts.

While we have in mind the very considerable additions to our naval strength which are being made, and particulars concerning which have already appeared in our columns, we regard the programme of construction just commenced as altogether inadequate to the requirements of the country. The British realm advances in dimensions by leaps and bounds. The growth of the population of the Queen's dominions augments rapidly. The bond between our colonies and the mother country has been drawn closer and closer. These and other considerations emphasize the responsibilities of the government; and accentuate the importance of the command of the seas. We want more ships of all kinds. It is a vain thing to dispute concerning this type or that type. We need ships of every type that is likely to be serviceable. We have no sympathy with hysterical pessimists who run about crying ruin, and denouncing our naval policy; but we have nothing to say on the other hand in favor of those who hold that our navy is quite strong enough. It could only fulfil this condition if our neighbors rested content to let their naval dockyards lie idle. Our existing navy would only suffice if the wealth of our colonies and the limits of our dominion remained fixed. The expansion of the empire must needs be accompanied by the development of the forces by which alone that empire remains ours. It is not necessary even to take count of territory added to our possessions. The increase in wealth is ample reason for the taking of unparalleled precautions to secure it. A Liverpool or a Sydney, poverty stricken, would hold out small temptations for aggression. As they are, Blucher's words when he saw London, may be remembered, "Himmel; what a city to sack!"

It seems to have been admitted by Mr. Goschen and the Government last session that additions to the navy were desirable, but that they could not be made; because, in the first place, all the government yards were full. Secondly, because private firms were too busy to accept orders. Thirdly, because armor-plates could not be had in time. The fallacy of every one of these statements has been demonstrated; at the most they represented half-truths. The precise reason why more ships were not laid down will probably remain a Whitehall secret. Various hypotheses were framed to explain Mr. Goschen's policy. It has been said that no designs for ships were ready; that the Admiralty could not make up its mind how to spend money. On another hypothesis, the ships were not ordered because there were no crews to be had to man them. Lastly, it was urged that such a dearth of officers—and particularly engineer officers—existed that it would have been quite useless to build more ships, because they could not be put in commission. It is noteworthy, however, that in all this storm of surmise and censure, no one ventured to hint that Parliament would not vote the necessary supplies. In point of fact, if an adequate programme were declared when Parliament meets,

and the Admiralty asked for £10,000,000 a year for the next five years, the money would be voted without a dissenting voice, save, perhaps, the petulant wailing of the few "Little Englanders" who have found their way into Parliament, and there serve the same useful purpose as the traditional "Frightful Example" at temperance meetings. It is, however, not to be disputed that confidence in the Admiralty has been somewhat shaken; and with every desire to allow for difficulties, we are by no means certain that ten millions would be spent to the best advantage under the existing system.

There is such a thing as a paper fleet, and there are critics—competent critics too—who do not hesitate to say that there is rather too much paper about our fleets. It is useless to possess ships which cannot fight. Unfortunately not a few ships, and these among the latest additions to our navy, have been in plain phrase failures so far. While the Boiler Committee is pursuing its labors, we do not propose to criticise Belleville boilers. But committee or no committee, we cannot shut our eyes, and we do not want to shut our eyes to unpleasant facts. The Europa, a new and so-called first-class cruiser, has been disabled by one voyage to Australia and back, and is now under repair. The Hermes after a disastrous experience is now lying in Bermuda. The Pegasus was disabled after an eighteen months' commission. The Powerful is undergoing heavy repairs at Portsmouth. The difficulties with the Terrible and Highflyer no longer excite attention. The Diadem, the Argonaut, and the Arrogant have all proved unsatisfactory; and all this while our battleships with Scotch boilers keep the sea and do good service. Nor is it the boilers alone which are open to criticism. It seems to be by no means certain that the machinery is not also in fault. When we read of the enormous consumption of steam by auxiliaries, we fancy that old times have returned when six pounds of coal per indicated horse-power per hour was a thing to boast of as representing great economy. Again, it would seem that there is not a cruiser afloat which has a properly made condenser. Nor does the matter end here. In naval circles it is held that we have many fighting ships which would be wholly impossible in action; that, in fact, they would be blown to pieces in five minutes by modern vessels. Care must be taken that nothing of the kind finds its way into the new programme; and it should not be forgotten that the enormous improvement which has been effected in armor, making a 5-inch plate at least as good as one of the older kind of twice that thickness, has given the naval designer scope for providing protection in a way hitherto unknown. It may, however, be assumed that all these points will be fully considered by the Admiralty. But it is once more necessary, we think, to urge the folly of providing Belleville boilers in ever increasing numbers. The last discovery is that if only lime enough is put into them they will no longer give trouble. In a few months it will also be discovered that there is nothing at all new in the use of lime; that it may well prove a remedy worse than the disease; and that it will quickly drop out of use again. In the providing of boilers we counsel patience. It will be well to wait until the report of the committee is laid on the Admiralty table.—*The Engineer*, Nov. 2, 1900.

TURBINE STEAM ENGINES.

A discussion of some interest has recently taken place between Mr. Parsons and Mr. Thornycroft concerning the relative merits of the Viper,

which has attained a speed of 36.858 knots, with turbine engines, and the Albatross, constructed by Messrs. Thornycroft & Co., which has a speed of about 31 knots. It appears that at less than full speed the turbine is not economical, and in practice it is found that while one ton of coal will take the Albatross 22.6 knots, the same quantity will take the Viper a little less than 12 knots, the speed in both cases being 15 knots. For the moment we are not concerned with that branch of the controversy which deals with the merits and demerits of these boats for fighting purposes. It may be argued that, as torpedo destroyers are after all not well fitted for cruising, one with a very high speed for a spurt must be better than the slower boat which can keep the sea longer. Our purpose now is to consider why the turbine engines should be less economical at slow than at high speeds.

In its construction the steam turbine closely resembles the water turbine. There are vanes which move and guide blades which remain at rest. It is important to bear in mind that in both these machines there is at all times a clear passage right through the wheels. There is nothing to arrest the flow of either water or steam through them. The effect of this is that if we block a water turbine so that it cannot revolve, nearly as much water will flow through it as if it was at work. If we block the revolving drums of a Parsons turbine the steam will flow through, almost as fast as if it was revolving. If we take the water turbine and examine it when blocked, with the water passing through it, it will be seen that the water leaves it at about the same velocity with which it entered it. When revolving it leaves it at a much smaller velocity. In some turbines the quantity which can be passed through the blocked wheel is actually greater than that which will pass when the wheel is working. Precisely the same statements hold good of the steam turbine. Theoretically a perfect water turbine would deliver the water at no velocity; of course, such a condition is a practical impossibility. Without touching on the mathematics of the subject, which are of small practical value for our present purpose, it may be said that there is a velocity for the rotating wheel which is better than any other velocity, higher or lower. The greater the head, the faster must the turbines run, and, broadly speaking, it may be said that the best economical result is obtained when the velocity in feet per minute of the revolving wheel is about one-half that of the water. Now, in the steam turbine there is a speed which bears a close relation to the maximum efficiency, and this speed is very high. In order to make the facts clear, we may use a simple illustration. Let us suppose a number of balls to fall from a height on a movable inclined plane. The balls move vertically. If, now, the inclined plane is drawn back, base first, sufficiently fast, the balls will continue to move vertically, and will exert no pressure on the plane. If, on the other hand, the plane is held fast, then the balls will exert an effort on the plane, tending to drive it back, and they will themselves be deflected toward the toe of the plane and will roll down it. The problem is to take as much as can be taken out of the balls in the shape of the driving effect on the plane; and to this end the plane must move at a speed which bears a definite relation to its angle of inclination and the paths of the balls. We may with strict propriety consider that steam as made up of myriads of little balls moving at a very high velocity, and the inclined planes, or their equivalent the vanes of the Parsons turbine, must also move at a very high velocity in order that the *vis viva* of the steam

may be transformed into torque energy with the least waste. In the steam dynamo there is a constant reversal of the direction of the current, but with this we need not further concern ourselves. In any case, the steam must escape with some remaining velocity and momentum, and this is waste. If the machine runs too slowly, steam will to all intents and purposes pass through it without doing any work. On the other hand, if it runs too fast, the steam will again flow through it without doing any work. We come back to the starting point. There is a velocity which is better than any other, and, indeed, so much better that any departure from it is productive of great loss of efficiency. As the speed depends on the velocity with which the steam moves, it may be thought that by reducing the pressure of the steam, and thereby its velocity, less power can be got without loss. This is no doubt true to a certain extent; but it cannot do much in practice, because the velocity of flow of steam does not vary directly as the pressure, but as given by the formula, $v = 3.5953\sqrt{h}$, where $v =$ the velocity of outflow in feet per minute for steam of the initial density, and h the height in feet of a column of steam necessary to give the pressure. To illustrate the bearing of this formula on the question discussed, we may say that, according to Brownlees' classical experiments, while steam of an absolute pressure of 30 lbs. on the square inch flows into the atmosphere at a velocity of 1401 feet per second, steam of 100 lbs. pressure has a velocity of 1459 feet per second. From which it will be gathered that the speed at which a turbine is most efficient is very little affected by the boiler pressure. In other words, the low-pressure turbine will have to run nearly as fast as the high-pressure turbine. Certain conditions modifying this come into play, no doubt, but the fact remains unaltered, that any considerable departure from the speed of maximum efficiency results in a greatly increased consumption of steam. This is one principal difference between the engine built by Mr. Parsons and that made by Mr. Thornycroft. Lastly, in this connection we may say that the comparatively moderate consumption of steam in the Parsons engine—20 lbs. or so per brake horse-power per hour—is due to the way in which the steam is used, because of which initial condensation is reduced to a very small amount. In a word, steam remains steam in the Parsons engine to a greater extent than it does in the reciprocating engine.

So far we have only dealt with the turbine engine as an engine. We have now to consider its efficiency when combined with a screw propeller. It will be readily understood from what we have said that the velocity of the moving vanes in feet per second must be very high. In the United States many patents have been taken out for engines in which a moderate speed of rotation is combined with a high angular velocity of vane, by making the diameter of the wheel large. But this cannot be done in torpedo destroyers with moderate draught, say 7 feet. The result is that the rate of rotation of the screws reaches 2500 to 3000 revolutions per minute. The compulsory result is that the pitch of the screw must be extremely fine. But a fine pitch always means that the surface velocity of the screw must be very high if the boat's speed is high; and another direct consequence is that the loss of power due to the surface friction in the water of the propeller is great. Here, again, we have the peculiar case of a certain velocity of maximum efficiency, to say nothing about cavitation or a cutting of a partial vacuum, so to speak, in the water. We have a speed, and surface, and pitch, which are better than any

others; and it is admitted very readily by Mr. Parsons that the surface or blade area of screw which is correct for the maximum speed of boat is much too large for low speeds. It is well known that for all steamships there is a speed of engines and ships which is more economical than any other speed, but with reciprocating engines running at moderate speeds—anywhere, that is to say, between 60 revolutions for a tramp and 300 revolutions for a torpedo destroyer, there are wide margins, variations within which will very little affect the result. Thus, for example, a torpedo destroyer running at 10 knots, will probably burn less coal per horse per hour than will be used when she is running at 20 nots, and a good deal less than when she is running at 30 knots, but even then the differences are not large. With the turbine, however, the case is different. With such a boat as the Viper it is all or nothing. At extreme speed she may beat the reciprocating engine also at extreme speed in steam consumption per horse per hour; but at any other speed the turbine loses, and at half-speed or thereabouts economy goes to pieces. Not only is the engine wrong, but the propellers are wrong. We do not for a moment contend that this fact is one greatly to the detriment of the turbine engine. Nothing of the kind. The only effect that a fixed and extremely contracted relation between speed and economical efficiency has is that it narrows the limits of application of the turbine engine. Such an engine, for example, might be in every way satisfactory for steamers running between Dover and Calais; Holyhead and Dublin, or even between Liverpool and New York, while they would be wholly unfit for a man-of-war. In the first cases the speeds are always the maximum practically possible, and there would be no difficulty in designing engines to suit. In the navy the speeds are wholly various, and for various speeds the turbine steam engine is not suited. It must not be forgotten, again, that in a large vessel there would be room for turbines of considerable diameter, and so the velocity of rotation of the screw might be fairly moderate. All things considered, we think it by no means improbable that the turbine steam engine will be largely adopted in the mercantile marine for special high-speed services of the ferry type, such as the Atlantic passenger trade, but for warships it is wholly unsuited, the success of the Viper to the contrary notwithstanding, because she is not a warship.—*The Engineer*, Oct. 26, 1900.

MARCONI'S LATEST DEVELOPMENTS—SYNCHRONIZED MESSAGES.

At the annual gathering of the British Association for the Advancement of Science, in 1899, Prof. Fleming of University College, London, addressed the gathering upon Wireless Telegraphy, and incidentally mentioned that while transmitting messages from Boulogne to Dover they were read at Chelmsford, some 118 miles from the point of transmission. This, undoubtedly, was a remarkable performance, but it also emphasized very forcibly one drawback which has long occupied the unremitting attention of Marconi. That is, the possibility of one or more stations reading a message intended for another. Such a circumstance naturally destroys the privacy of the message, and although it is not a very significant matter in the ordinary way, yet it would be a very serious

drawback, in case of war, for one belligerent to be able to intercept and to read a message that was being transmitted between the vessels of the other belligerent. Marconi quickly realized the serious nature of this disadvantage, and at his station at Poole, in Dorsetshire, England, he has been endeavoring for a long time past to successfully synchronize his messages; that is, to construct a transmitter, the message from which can only be received by the apparatus which has been tuned to receive it.

He has successfully solved the problem, by means of variable conductors and capacities, by the use of which certain instruments can only receive certain messages. By his latest system, Marconi can dispatch from a certain point any number of messages, and each message will be received only by that receiver that has been synchronized to the transmitter, so that jamming of words and confusion of messages upon the various receivers are obviated.

Marconi has set up his station at Poole because that place is so remote and he is safe from interruption. Twenty odd miles away across the Solent is another station at the southwestern corner of the Isle of Wight. Between these two points messages are being transmitted throughout the day, almost without cessation, and this is how several important discoveries and improvements have been made by the inventor. While experimenting with his synchronizing system, Marconi had several opportunities of proving the capabilities of his device. At Portsmouth the English Admiralty were carrying out experiments with wireless telegraphy in connection with the fleet, and naturally several of these ether waves crossed Marconi's line of transmission between Poole and the Isle of Wight, the effects of which upon his instruments the inventor regarded with the utmost satisfaction, since they proved that he had finally surmounted the most perplexing disadvantage of his system.

Marconi has also made some other important discoveries. He now utilizes cylindrical tin cans, about five feet in height, in lieu of the vertical wires, since they furnish more convenient capacities and radiators. He is lengthening the distance over which messages may be transmitted, and although his experiments at Poole can be conducted only on a limited scale, yet he is confident that when he works upon a larger station they will be equally successful, and there is no doubt but that many important developments in ether telegraphy will be divulged in the near future.

At the present moment Marconi has a sufficiency of work on hand. The North German Lloyd Steamship Company are having one of his systems installed at Berkum (Germany), to be used in connection with their fleet of vessels. Apropos of this, Marconi has been carrying out many experiments with a view to applying the system practically to shipping, so that greater safety may be assured to vessels at sea. Then the International Company of France are having the coast of that country, metaphorically speaking, lined with his installations, so that communication may be maintained between the vessels of the French navy and any point of the mainland, which would play an important part in case of a war between England and France, since by this means the latter nation could manipulate their troops according to the information received from their battleships, and thus be able to work the land and sea forces hand in hand. Then six stations are being set up in the Hawaiian Islands and will soon be in working order. Many vessels in the English navy are also having the system installed.—*Scientific American*, Sept. 8, 1900.

NAVAL CONSTRUCTION IN FRANCE.

The constructions to be carried out by the French government during 1901 comprise 111 vessels, and among these figure the battleship Iena, which is already in service, and is only down on the programme to account for a balance to be paid next year. Two submarine boats, the Français and Algerien, are completed, and will shortly be launched, and three squadron and six coast-defense torpedo-boats will also soon be finished, so that they cannot properly be included in the programme for 1901. Excluding these, there are four battleships, fifteen armored cruisers, a first-class cruiser, twenty-four destroyers, fifteen submarine boats, seven squadron torpedo-boats, thirty-two torpedo-boats, and the unfortunate aviso-transport above mentioned. Of the battleships, the Henri IV and the Suffren, which have been built at Cherbourg and Brest respectively, have been launched, and their armaments will be completed six months hence. Two other battleships will be put on the stocks as soon as the grant voted by the Chamber is ratified by the Senate. One is to be constructed at Brest and the other in a private shipyard. These will be another addition to the multifarious types already existing in the French navy, and were proposed by the Commission of the Marine and introduced by the Minister, who was strongly supported by the naval deputies. The Chamber had so long shown an uncompromising antagonism to battleships, that the approval of the government scheme was a victory for the old school. Each of the battleships will have a displacement of 14,865 tons, and the engines will develop 14,475 horse-power. The maximum speed is to be 18 knots, and steaming at 10 knots the ships will have a range of action of 8930 miles. The armament will be composed of four heavy guns, eighteen guns of medium caliber, and twenty-eight small guns, as well as five torpedo-tubes. Of the fifteen armored cruisers, fourteen are on the stocks, and the Jeanne d'Arc, of 11,270 tons, will be entirely completed next year. The Montcalm, now building at La Seyne, will also be finished in 1901. This vessel has a displacement of 9517 tons—the same as the Gueydon and Dupetit-Thouars, which will be launched in 1902. Five other armored cruisers, the Marseillaise, Gloire, Condé, Amiral Aube, and Sully, have each a displacement of 10,014 tons. The two first named will be finished in 1902, and the others in the following year. The Desaix, Dupleix and Kléber, each of 7700 tons, are built partly of wood, and are intended for service in the tropics. All three will be launched in 1902. The Léon Gambetta and Jules Ferry are new types of armored cruisers, with a displacement of 12,550 tons and with engines of 27,500 horse-power, and are expected to attain a speed of 22 knots. These vessels were put on the stocks this year. Two others of the same type will start building at Toulon next year. The Jurien-de-la-Gravière is a protected cruiser of a type which has been abandoned.

The government has given up the construction of small torpedo-boats, but is turning its attention to boats of a larger tonnage, as well as destroyers, which form an important factor of the new programme. Fourteen destroyers are on the stocks, and ten others will be started upon next year. So far all the destroyers have been built in private yards, but Rochefort is beginning to give a great deal of attention to them, and orders for ten destroyers have recently been placed at the government shipyard. Three of these will be completed next year, and

the remainder in 1902. Rochefort is to receive orders for two new destroyers. Two others have been put on the stocks at Havre this year, and fourteen are to be ordered from private shipbuilders. The destroyers are taking the place of the squadron torpedo-boats, which are found to lack sufficient sea-going qualities, and it is not likely that any more will be built after the seven now under construction at Havre and Bordeaux have been delivered. Three others mentioned in the programme are already completed. Of the thirty-eight first-class torpedo-boats, two are building at Cherbourg, two at Toulon, and two at Saigon. Private yards have already delivered eleven boats, including a turbine boat, the Libellule, and have ten under construction, while eleven others will be put on the stocks next year. In submarine boats the French navy is not likely to belie its traditions with respect to multiplicity of types, for in its haste to get a submarine fleet the government orders vessels of any type which seems to give fairly satisfactory results. The process of weeding will doubtless take place later on, when experience has shown what are exactly the limitations of the new boat, and under what conditions it can reasonably be expected to be of service. Seventeen submarine boats are provided for in the programme, and eight others will probably be ordered next year, these being all constructed in the government shipyards. All these vessels are more or less experimental, and French naval critics are by no means satisfied yet as to their efficiency.—*The Engineer*, Oct. 19, 1900.

ARMOR-PLATE TRIALS.

It is perhaps scarcely necessary to state that it has always been a difficult matter, even under old conditions, to meet the high standard armor-plate requirements of the British Admiralty; but since the advent of Krupp armor the task of meeting requirements has been rendered still more severe. To enable them successfully to overcome these difficulties, Sir W. G. Armstrong, Whitworth & Co., have from time to time carried out various experiments on lines laid down by themselves with the object of producing armor-plates of the highest quality. Early on in the year they were in a position to submit to the Admiralty two 6-inch plates, produced at their Manchester works by a special process of their own. On July 3 these plates were placed under official preliminary trials at the government testing station on Whale Island, Portsmouth. These plates were of the normal size for trial purposes, viz., 8 feet by 6 feet and 6 inches thick, and were installed in the frames provided in the proof cells Resistance and Thundered. The trials were conducted under the superintendence of Captain W. H. May, of the Excellent, and Lieutenant S. R. Drury-Lowe, R. N., whilst the Admiralty was represented by Lieutenant G. P. Hope, for the Director of Naval Ordnance, and Mr. W. E. Smith for the Constructors' Department. Mr. Saxton Noble (Director) was also present on behalf of Elswick, and Mr. J. M. Gledhill for the Openshaw works. Five shots were fired at each plate with Holtzer armor-piercing shell at the velocities laid down for this thickness of plate in cemented steel. Both plates defeated all the projectiles, and were pronounced as satisfying in every respect the service requirements.

The table given is copied from the official report of he trials.—*The Engineer*, Oct. 5, 1900.

ARMOR PLATE TRIALS. REPORT ON ARMSTRONG, WHITWORTH, AND CO.'S 6 IN. PLATE, TESTED AT WHALE ISLAND ON JULY 3, 1900.

Thickness of plate, 6 in. Rounds fired, five. Backing, thickness, top and bottom, 3 ft. 9 in.; centre, 3 ft. 8¼ in. Secured by eight bolts.

Round.	Gun used.	Weight of projectile.	Point of striking.	Effect on front of plate.	Effect of striking on projectile.	Remarks.
1	6 in. Q. F.	Holtzer, 100½ lb.	2 ft. from right edge, 2 ft. from bottom.	Penetration, depth 2⅜ in.; size of injury 19⅛ in. × 18⅛ in.	Projectile broken up	Striking velocity 1998 f. s., energy 2768 foot-tons.
2	"	Holtzer, 100 lb.	2 ft. from left edge and 2 ft. from bottom.	Penetration, depth 2⅝ in.; size of injury 23¼ in. × 14 in. Slight surface crack towards right edge. Piece of projectile of round 1 jarred out.	" "	Striking velocity 1974 f. s., energy 2702 foot-tons.
3	"	" "	2 ft. from left edge and 2 ft. from top.	Penetration, depth 2⅛ in.; size of injury (1) 12⅜ in. × 11⅛ in. (2) 23¼ in. × 18⅝ in. Further scaling and surface crack to left edge, developed in round 2. Further scaling.	" "	Striking velocity 1970 f. s., energy 2691 foot-tons.
4	"	" "	2 ft. from right edge and 2 ft. from top.	Penetration, depth 2⅝ in.; size of injury (1) 12 in. × 11 in. (2) 20¼ in. × 18⅝ in. Plate slightly bulged. Further scaling on round 3.	" "	Striking velocity 2024 f. s., energy 2841 foot-tons.
5	"	" "	3 ft. from right edge, 4 ft. from bottom.	Penetration, depth 2¼ in.; size of injury 21⅝ in. × 18⅛ in. Surface crack upwards to left upper corner towards No. 3.	" "	Striking velocity 2047 f. s., energy 2804 foot-tons.

THE COMPARATIVE EFFICIENCY OF THE KRUPP, ARMSTRONG AND SCHNEIDER-CANET GUNS.

In determining the relative efficiency of modern guns there are many elements to be taken into consideration, particularly in the case of weapons which are intended for naval service, where velocities are usually much higher than those common in weapons for field service. A comparison of relative efficiency must take note of all ballistic features. As a matter of fact, the methods of designation used are apt to be misleading, for the reason that they make too much of certain elements of efficiency, and too little of others. Thus, we find that, popularly speaking, it has become the fashion to quote the muzzle velocity of a gun in preference to any other of its ballistic capibilities. If the public hears that a gun of a certain caliber is capable of a muzzle velocity of 3000 feet per second, as against velocities of 2600 or 2800 feet per second in other guns of the same caliber, it is apt to consider that the high-velocity weapon is incontestably the most effective. This superiority, however, by no means follows; for the mere statement of the muzzle velocity, unaccompanied by any statement of the weight of the shell to which such velocity is imparted, conveys no information as to the actual hitting power of the gun. Then again the relative efficiency may further be modified by a statement of the weight of the gun itself, for it is evident again that if two guns, one of which is considerably lighter than the other, show the same muzzle energy, the lighter gun is ton for ton a much more effective weapon. A further modification is introduced when the question of the "remaining velocity and energy" is introduced; for although a light projectile, issuing from the muzzle of a gun at an extremely high velocity, may have the same muzzle energy as a heavier projectile with a lower muzzle velocity, the lighter projectile will lose its velocity far more rapidly as the range is covered, and what is known as the "remaining velocity and energy" of the heavier shell will be relatively greater, the greater the distance that is covered. It is mainly for this reason that many of our naval officers regret to see the 13-inch guns displaced by the 12-inch, the hitting power of the 13-inch shell at long ranges being considerably greater than that of the lighter 12-inch shell.

In determining upon the armament of their navy, the Germans have evidently been governed by this consideration; for it is a fact that the Krupp guns, with which their ships are armed, fire projectiles which are considerably heavier for any given size of gun than those used in any other navy. Although the muzzle velocities given in the ballistic tables of these guns are not so high as those of other nations, the muzzle energies are greater and the "remaining energies" are in some cases enormously so. Just how great is this difference is shown in an article which we publish in the current issue of the *Supplement*, which contains a series of graphical comparisons of the relative ballistic energies of the Krupp guns and those of the great firms of Armstrong and Schneider-Canet.

Thus, in comparing the velocities and energies of the Krupp 9½-inch gun with the Armstrong weapon of the same caliber, we find that, although the muzzle velocity of the Armstrong projectile is 762 meters per second, as against 729 meters per second for the Krupp gun, at 179 meters from the muzzle the velocities are equal, and at 5000 meters the

Krupp has a remaining velocity of 491 meters, as against a remaining velocity for the Armstrong shell of only 448 meters per second. The loss of velocity is due to the fact that the Armstrong projectile, weighing only 159.7 kilogrammes, as against 218 kilogrammes for the Krupp projectile, is more influenced by the resistance of the air, and therefore loses its velocity more quickly. Although the velocity of the Armstrong weapon is 33 meters greater than that of the Krupp gun, its muzzle energy is 1098 meter-tons smaller, and at a range of 5000 meters its energy is still 1012 meter-tons less. Judging the two guns on the basis of the amount of energy developed per kilogramme of weight of gun, we find that at the muzzle it is for the Armstrong 176.8 meter-kilogrammes per kilogramme of weight of gun, and that in the Krupp weapon it is 214.4 meter-kilogrammes per kilogramme of the weight of the gun.

Comparing the guns on the basis of their armor-piercing ability, it is shown that while the Krupp 9½-inch rapid-fire gun can perforate 30 centimeters of Harveyized armor up to 3100 meters range, an Armstrong gun of the same caliber, in spite of its greater velocity, can do this only up to 1250 meters. Harveyized armor 25 centimeters thick is perforated by the Krupp gun up to 4500 meters, by the Armstrong gun only up to 2400 meters, while the Schneider-Canet 9½-inch gun cannot perforate that thickness at a range of over 2000 meters.

Although a strong case is made out for the superiority of the Krupp guns along the lines referred to, there is one drawback to the use of the heavier projectiles which must not be lost sight of. We refer to the fact that the greater weight of the shell will reduce the total number of rounds that can be carried for each gun; a consideration which is of importance where every ton of the displacement of a ship is valuable when it comes to the question of distribution among the contending claims of armor, engines, stores and ammunition. Furthermore, the increased weight must tell somewhat against the rapidity of handling; and if the ammunition is to be handled at the same speed, it becomes necessary to install heavier machinery for operating the hoists.—*Scientific American*, Dec. 1, 1900.

THE NEW 12-INCH NAVAL GUN.

The new 40-caliber, 12-inch gun, the first lot of which will be mounted on the new monitors and on the Maine class of battleships, and which will henceforth be the standard weapon of this caliber for our navy, has been completed and tested at the Naval Proving Grounds, Indian Head; about twenty rounds having thus far been fired.

With a charge of 360 pounds of smokeless powder, and a projectile weighing 850 pounds, a muzzle velocity of 2854 foot-seconds was obtained with a corresponding muzzle energy of 47,994 foot-tons, the chamber pressure being 16½ tons per square inch, or a half ton less than the designed working pressure of 17 tons. We are informed that the gun, its mechanism and mount functioned admirably in every respect. The Bureau of Ordnance is to be congratulated in having achieved such admirable results.

The fact that this gun shows 54 foot-seconds greater velocity than it was designed for, with half a ton to the square inch less pressure in the powder chamber, speaks volumes for the excellence of the multiper-

forated, all-guncotton smokeless powder which has been adopted by the navy; for unlike the high nitroglycerine powders, such as cordite, which are used by some other nations, our new navy powder achieves these splendid results without any perceptible deterioration of the inner surface of the gun.

It is interesting to compare the new weapon with the 12-inch 35-caliber guns now in service. The new gun weighs 53.7 tons and has a muzzle energy of 893 foot-tons per ton of gun. The present 12-inch gun, which weighs 45.2 tons, has a muzzle velocity with smokeless powder of 2300 foot-seconds, and the corresponding muzzle energy of 31,170 foot-tons amounts to only 689 foot-tons per ton weight of the gun. From the above comparison it will be seen that the muzzle energy of the new 12-inch gun exceeds that of the old by 53 per cent.

COMPARISON OF 12-INCH, 40-CALIBER NAVAL GUNS.

	Weight in tons of gun.	Weight in pounds of projectile.	Muzzle velocity feet per second.	Muzzle energy in foot-tons.	Foot-tons energy per ton of gun.
United States, Naval	53.7	850	2,854	47,994	893
German, Krupp	48.9	981	2,592	45,662	934
British, Vickers	50.3	850	2,600	39,843	792
British, Armstrong	50.8	850	2,580	39,233	772
British, Naval	50.0	850	2,481	36,290	726
French, Naval	45.9	644	2,625	30,750	670
12-INCH GUNS OF 35 AND 50-CALIBER.					
*United States Naval, 35-caliber	45.2	850	2,300	31,170	689
Krupp, 50-caliber	62.4	981	2,953	58,205	934
Krupp, 50-caliber	62.4	771	3,330	58,205	933

*Old pattern as used on Iowa.

If the energy developed by one round of the new gun could be applied as a constant upward thrust beneath a 12,000-ton battleship, it would be sufficient to raise it 4 feet from the ground.

The excellence of this weapon is shown by a comparison with other 40-caliber, 12-inch guns, which are being constructed by the leading gun-makers of the world. At the bottom of the list is the French gun, which, in spite of its high velocity, shows a muzzle energy of only 30,750 foot-tons, the relatively small energy being due to the very light shell, which weighs

only 644 pounds. The inferiority of this gun is greater than appears on the surface figures; for the lightness of the shell will cause the velocity of the projectile to fall away far more rapidly than that of the heavier projectiles. We should note in this connection that although the muzzle velocity of the Krupp 40-caliber gun is lower than that of the new United States gun, because of the greater weight of its shell, it will approach it in respect of its remaining energies at the longer ranges. Judged by the muzzle velocity and muzzle energy, the new United States weapon stands easily first; but judged by the standard of energy per ton weight of the gun, it will be seen that the Krupp weapon has a considerable lead. It would be interesting, in this connection, to note how Krupp obtains these results with a gun so comparatively light in weight. It is possible that this gun is constructed of nickel-steel, and that an abnormally high chamber pressure is allowed.

Following the table of the 40-caliber guns are placed three guns of 35 and 50 calibers, the first being the type of 12-inch gun at present in use in our navy, and the 50-caliber guns being two of the 1899 Krupp models, which the company state have actually been manufactured and tested with the results herewith shown. The enormous energy of 58,205 foot-tons is obtained in the first of these two weapons with a 981-pound projectile having a muzzle velocity of 2953 foot-seconds, and in the second by a 771-pound projectile driven at 3330 foot-seconds velocity, the energy of 934 foot-tons per ton weight of gun being, as far as we know, the greatest efficiency yet obtained with any gun, experimental or otherwise. As this gun is over 50 feet long, however, it is altogether too unwieldly for service on shipboard, at least according to the present accepted ideas on the subject.—*Scientific American*, Dec. 15, 1900.

INTERESTING EXPERIMENTS WITH TORPEDOES.

Some elaborate experiments to test the explosive force of torpedoes have recently been carried out on an uninhabited island in the Trans Sound, an inlet of the Gulf of Finland. The officials in charge of the trials erected a galvanized hut. In this they placed a torpedo-tube charged with a Whitehead torpedo, the nose of which projected from the tube, as it would if placed on board ship in time of war. The idea of this particular test was to ascertain what would occur if a shot was to penetrate the torpedo-tube on board a battleship while charged with a torpedo. With a view also of obtaining some idea of what effect such an explosion would have on the members of the crew, a number of sheep was permitted to graze in the vicinity of the hut. The air in the air chamber of the tube was compressed to eighty atmospheres. The shot, fired from a safe distance, penetrated the wall of the hut and entered the air chamber of the tube. No explosion resulted, but the imprisoned air rushed through the hole caused by the bullet with a terrific noise, but no damage was caused. The next experiment was to explode 187 pounds of guncotton inside the hut near the head of the torpedo protruding from the tube. The explosion was effected by means of a twenty minutes' time-fuse, so that the officials might have sufficient opportunity to get away from the spot. Some of the officers took up positions upon a small neighboring island. The sheep, as before, were grazing around the hut. The guncotton exploded with a terrific report, and no doubt also fired the

charge within the torpedo, since the tube, shed and the sheep near were blown to pieces.

Strange to say, a sheep seventy-five yards from the hut was absolutely uninjured, thus proving that the force of the explosion was local. The officers who watched the operations from the neighboring island experienced a severe concussion of air. The officials now procured a pontoon which they had covered upon the bottom surface with four thicknesses of armor-plate. This was placed in shallow water and a torpedo was fired from a tube so as to strike the protected bottom of the pontoon. The result of the impact was that the pontoon was blown into the air.—*Scientific American*, Oct. 27, 1900.

GATHMANN AERIAL TORPEDO GUN.

An American contemporary has given us some striking figures and results obtained by the big Gathmann aerial torpedo gun constructed at Bethlehem, which is shortly to be tested by the Board of Ordnance, of which General Miles is president. This weapon is 18 inches in caliber, and is 44 feet in length, yet it weighs only 59 tons. The exterior dimensions so closely resemble those of the 12-inch gun that it can be mounted on the 12-inch gun-carriage. The weight of the torpedo shell is 1800 lbs., and it carries 625 lbs. of wet guncotton. The muzzle velocity is about 2200 feet per second when fired with Gathmann's smokeless powder. Engravings accompany the statements, showing, first, an armor-plate after being struck by three 12-inch projectiles, by which it appears that the plate is practically uninjured; and, secondly, the *débris* of the entire structure plate and backing after the impact of a single Gathmann shell. Mr. Gathmann has been the best part of twelve years developing this gun, and the writer remarks that if the piece "will do half what its advocates claim for it, the ingenuity of man will be severely taxed to invent some system of defense that will successfully resist it."

We agree with the writer in this conclusion, but we think that the "if" should be written very large indeed. Some months ago we spoke of a large-caliber gun being constructed at Bethlehem under the direction of Lieut. Meigs, which, carrying a large explosive at a moderate velocity, might, we thought, for many purposes be a most valuable gun, but we never committed ourselves to such statements and figures as those given above. Without going into actual calculation here, it will be apparent that the above are beset with difficulties. To begin with the gun, it is of the same external dimensions as the 12-inch piece, which is only two-thirds of its caliber. This implies a very light thin breech, for doubtless the breech only is contemplated, and we certainly do not want to increase the difficulties presented to us. It would be supposed that this must be a low velocity gun, yet 2200 foot-seconds cannot even now be called a low velocity. Then the torpedo shell weighs 1800 lbs., as against the 2000 lbs. of the 17-inch 100-ton gun. The cubes of 18 and 17 are nearly in the proportion of 8 to 7, so that this means that the torpedo 18-inch shell is very much slighter, taking the weight into account—almost a quarter less—solid and strong, even supposing it to be of somewhat similar form. Seeing that it contains 620 lbs. of wet guncotton, however, it must be a projectile of very great length, and consequently its structural strength must be slight indeed, and for the attack of armor prac-

tically useless. Wet guncotton is here spoken of as if it almost was a new substance, yet about ten years ago we reviewed results obtained by German artillery against land works with wet guncotton shells, this substance being at that time preferred by Germans to melinite and other high explosives. The effect of these shells was then found to be very great indeed. But mark what follows. General Brialemont then concluded—and we had the opportunity of hearing it from his own lips—that armored defenses were called for to defeat these destructive shells. The fact is that up to the present time explosives have only destroyed armor when carried well into it by a shell with some penetrating power. We admit that we do not know of so large a charge as 620 lbs. being employed, but that armor can be successfully attacked by a very weak shell containing even such a charge has to be shown. Present evidence is against it. Observe that the projectile never strikes direct on service, and the oblique breaking of such a projectile is a very much enfeebled affair. We will, however, go further; we have yet to be shown that the projectile will shoot. Without fully working it out, we can see that it has much against it, and is likely to fail just where all these mammoth explosive torpedo shells have hitherto failed—that is to fail in hitting the mark. The Vesuvius had nothing to prevent her proving the powers of her torpedo shells at Cuba, yet the official Spanish report was that the effect would have been terrible had the shell fallen "near a fort." A fort is a big enough object, and yet all efforts failed to lodge a shell even "near" one. It is never wise to ridicule the possibility of a design being good because inflated accounts are given of it. In this instance we think the accounts decidedly inflated, but what we think may be important as a solid residuum is what we wrote in the spring, namely, that under many conditions in warfare it may answer well to sacrifice high velocity for the sake of a shell carrying a large explosive charge for the attack of weaker structures. We have no evidence to indicate success in the attack of heavy armor. If this 18-inch gun is treated soberly it may, we think, have a future.—*The Engineer*, Aug. 24, 1900.

THE NEW FIRST-CLASS AUSTRIAN COAST-DEFENSE BATTLESHIP HABSBURG.

The new Austrian battleship which is now in the course of construction at the wharves of the Stabilimento Tecnico Triestino, and which is to bear the name Habsburg, is the first of a series of ships authorized by the Austro-Hungarian government. The Habsburg is a coast-defense vessel of 8340 tons displacement, 354 feet in length and 65 feet 9 inches in beam. She will draw 23 feet, will have engines of 11,000 indicated horse-power, which will drive her at a speed of 18 knots. The armor will consist of a belt of chrome-nickel steel 8.6 inches thick, extending four-fifths of the ship's length. The gun positions are protected by 8.2 inches of armor plating. The deck plating is composed of 2½-inch steel. The armament will be composed of three 9.4-inch rapid-fire guns, mounted in turrets, two forward and one aft; twelve 5.9-inch rapid-firing guns, mounted in two superposed rows so that four guns can be directed aft, four forward and six to each side; and twenty-four smaller guns of various sizes.—*Scientific American Supplement*, Nov. 10, 1900.

DUTCH TORPEDO-BOAT HYDRA.

The Hydra is one of two similar boats, the other being the Scylla. They are intended to strengthen the naval power of the Dutch authorities in their East Indian colonies. The boats are 130 feet long, 13 feet 6 inches beam, and have a displacement of about 90 tons. The contract speed is 23 knots. The machinery consists of a set of triple-expansion engines designed to indicate 1200 horse-power. The special feature of these engines, and in which they differ from those of other torpedo-boats, is the system of forced lubrication which has been adopted, the working parts of the engine being completely enclosed. This plan has been introduced with great success in many types of land engines, and is becoming a feature of modern high-speed engines in small sizes. The great advantage of forced lubrication is that all anxiety on the part of the engineering staff is set at rest as regards this the most important point in the proper working of such fast-running machinery. The auxiliaries include a centrifugal circulating pump with its engine for supplying the condenser with water, an evaporator and distilling plant in duplicate; steam steering engine and air compressor; dynamo for electric lighting; an overhead fan and fan engine in the stokehold between the two boilers for forced draft; also a Worthington pumping engine in the stokehold for feeding the boilers when the main engines are not working. The bunkers hold about 18 tons of coal. The armament consists of three 18-inch swivel torpedo-tubes and two 6-pounder quick-firing guns.

The official trial of the Hydra took place on May 25. A mean speed of 24.37 knots was made for the three hours with 160 lbs. of steam, and a trifle over 400 revolutions per minute, the load carried being 17½ tons.

The official trial of the Scylla took place on June 26, with practically the same results.—*Marine Engineering*, Oct., 1900.

H. M. S. ESSEX.

The four armored cruisers of the Essex class—Essex, Kent, Bedford and Monmouth—although a good deal heavier than the Bayan and Prinz Heinrich, with which we have recently dealt, are, for reasons stated in a recent number of *The Engineer*, to be regarded as of the same class.

The principal particulars of the type are as follows: Displacement, 9800 tons; length, 440 feet; beam, 66 feet; draught, mean, 24½ feet. Armament: fourteen 6-inch, 45 caliber; ten 12-pounders; three 3-pounders; and an indefinite number of Maxims, probably eight; torpedo-tubes, two 18-inch submerged.

In the arrangement of her guns the Essex closely resembles the Renown, and bears much the same ratio to the big armored cruisers of the Drake and Cressy classes that the Renown bears to the Majestic class, the only striking difference is that the Essex has the high forecastle common to all our cruisers now-a-days, and that the 12-pounder battery amidships is open as in the Duncan. As for these differences, the high forecastle is absolutely indispensable to a swift cruiser. Earlier cruisers, like the Blake and Edgar classes, suffer a good deal in bad weather from the sea they take in forward; the effect of which is noticeable in two vessels of the class—Crescent and Royal Arthur, which had their forecastles built up to improve their steaming qualities in bad weather.

The more or less open upper decks is, we believe, the result of a report sent in by Captain H. J. May, R. N., who pointed out that the high bulwarks in the Majestic, and later types up to the Duncan, would simply burst shells in the worst possible place, *i. e.*, just in front of men at the guns. We referred to this important question in our "Dockyard Notes" some months ago. The compromise in the Essex design falls a good deal short of Captain May's ideal—which was to have the 12-pounders absolutely unencumbered by boats, davits, stanchions, or anything else—still it is a vast improvement upon the older idea of high bulwarks. Not, however, that the high bulwarks must be dismissed as a mere thoughtless excrescence, for they serve at least two distinct uses. In the first place, many men are put to sleep on this deck in ships thus fitted—in the Essex this would not be possible owing to the low sides; in the second place, there is a theory, now pretty well established and proved, that men shoot better when they have the sense of protection—fallacious though this protection be—that these high bulwarks afford.

To resume the description of the Essex. The 6-inch guns are thus disposed: Two in a turret forward, two in a turret aft, six on the main deck amidships, and four on the upper deck above the forward and after main-deck guns. All these pieces are in armored casemates.

Six 12-pounders are on the upper deck amidships, two under the forecastle forward, two on the main deck right aft.

This is the armament of the Essex in the original design. The usual rumors about a change in her armament are now given currency, chiefly connected with the 7¼-inch quick-firer, which rumor has mounted in most of our new ships. Much mystery attaches to this gun, which was first spoken of in connection with the four last cruisers of the Diadem class. It is worthy of note, too, that the four upper-deck casemates in these ships are very large, and apparently designed to take such a gun. Possibly we are waiting for a foreign lead—as usual. In general, naval officers are mostly far from admirers of the cruiser carrying nothing but 6-inch guns. There is a feeling that 9.2 guns are wanted in the Diadem class, which, though much larger than the Elswick cruisers of the Asama type, carry fewer guns and no armor worth mentioning. The same thing applies to some extent to the Essex, as will be seen from the comparisons below:

	Essex class.	Asama class.	Diadem class.
Displacement	9,800	9,750	11,000
Horse-power	22,000	19,000	16,500 (18,000 in some)
Speed, knots	23	22	20.25
Main armament	—	Four 8 in.	—
Secondary armament	Fourteen 6 in.	Fourteen 6 in.	Sixteen 6 in.
Tertiary armament	Ten 3 in.	Twelve 3 in.	Fourteen 3 in.
Submerged tubes	Two	Four	Two
Armor deck	(?)	2½ in.	4 in.
Armor belt, amidships	4 in.	7 in.	—
" ends	2 in.	3½ in.	—
" lower deck	4 in.	5 in.	—
Turrets and bases	5 in.	6 in.	—
Casemates	4 in.	6 in.	6 in.
Coal, normal	(?)	550	1,000
Coal, Maximum	(?)	1,300	2,000

It should be noted that all fourteen 6-inch guns are protected in the Essex, in both the Asama and Diadem four 6-inch guns only have shields.

It may be observed that the Diadem class pay heavily in speed, guns and armor for the few hundred tons of coal extra that they carry, and to see their superiority over the Asama class needs a good deal of optimism. Nor, since the Diadem carries no guns capable of penetrating the Elswick cruiser's armor, is it quite clear how she could do her much harm.

The armor of the Essex is thin and extensive. There is a belt about 250 feet long amidships, of 4-inch Krupp cemented armor, and this belt extends right up to the main deck. It is continued to the bow at a thickness of 2 inches. Aft it is terminated by a 5-inch bulkhead. A curved protective deck runs throughout the length of the ship and reinforces the water-line protection. The space above and below is filled, as usual, with coal-bunkers. The casemates are 4 inches thick, the turrets 5 inches, but for these nickel armor, not Krupp, is employed. It has less resisting power, but is more easily worked. There is said to be great difficulty in using Krupp armor for circular or nearly circular turrets. These turrets have short armored bases of 5 inches thickness, with armored hoists going down the main deck.

The turrets are distinctive and, so far, peculiar to the Essex class. To begin with, the guns in each can be trained together and fired as one piece or else used independently. These guns, their mountings, and so forth, are to be furnished by Vickers, Sons & Maxim, Limited, who have brought out the design. Many details seem to be as yet provisionally decided on only, or were so a short time ago, pending exhaustive experiments. There is a single hoist to the pair of guns, worked by an electric motor. It serves with very great rapidity, and when in full working order delivers every alternate charge to the port gun, which has a special small motor to catch it as it comes up the endless chain. This arrangement can be easily disconnected—the hoist is then made to serve one gun only. This is merely a rough general description of a—for the British navy—absolutely novel form of hoist. It is, presumably for that reason, so far " strictly confidential "—but gunnery officers generally are very pleased with it. It remains to be added that three layers of projectiles are carried in the turret underneath the guns, which can be loaded in any position or elevation. Double hoists, adapted from the same system will, it is said, be fitted to the two-story casemates.

The Essex will have the usual rig for modern British cruisers, a search-light platform on each top, but no fighting-tops for guns. There will be three funnels. The engines are designed to give 23 knots with 22,000 horse-power. The boilers will be Belleville of the latest pattern, fitted with economizers. We may now proceed to compare the Essex class with the Russian Bayan and the German Prinz Heinrich, the ships with which—bearing in mind that the British custom of building ships 20 per cent or so heavier than foreign ones—they are intended to be on the same level. The difference is not entirely a matter of more coal, spare gear and more ammunition; indeed there is probably far less gain in these things than is generally assumed. This gain seldom seems to match the additional tonnage, and we fancy that the main point of difference should be looked for in increased habitability and seaworthiness, both points that, though they make small show on paper, would, in a war lasting a year or so, probably be more important than an extra gun or two. In the glib comparisons between British and foreign ships that are so often made now-a-days there is a curious ignoring of this very vital point. However, it is hardly one that can be reduced to statistics.

In the following comparison we omit any reference to the dimensions, and the tonnages are given chiefly as a general index. The powers of offense and defense are those upon which we chiefly desire to concentrate attention:

	Essex.	Bayan.	P. Heinrich.
Displacement	9,800	7,800	8,868
Horse-power	22,000	17,000	15,000
Speed (maximum), knots	23	21	20
Main armament	Nil	Two 8 in.	Two 9.4 in.
Secondary armament	Fourteen 6 in.	Eight 6 in.	Ten 6 in.
Tertiary " (protected)	Nil	Eight 3 in.	Nil
Tertiary " (unprotected)	Ten 3 in.	Twelve 3 in.	Nil
Small pieces	Three 3-pdrs. and Maxims.	Seven 3-pdrs.	Ten 1-pdrs. four Maxims.
Submerged tubes	Two	Two	Three
Above-water tubes	Nil	Three (2 protected)	One
Armor belt (amidships)	4 in.	8 in.	4 in.
Armor belt (bow)	9 in.	4 in.	3 in.
Lower-deck armour	4 in.	3 in.	4 in.
Protection to main armament	—	7 in. on each turret; 3 in. hoists to these.	6 in.
Protection to secondary armament	Four 6 in. in turrets with 5 in. armour. Ten 6 in. in casements. with 4 in. armour.	3 in. on three redoubts.	6 in. on turrets and redoubt.*
Protection to tertiary armament	Nil	3 in. on eight of them.	Nil

Nothing definite has appeared as yet concerning the coal supply of either the Essex or the Prinz Heinrich, so comparisons as to what the bigger ships may gain in this particular are not possible. But the Bayan is stated to be designed to carry no less than 750 tons normally, and 1100 tons maximum capacity. These figures, however, may not be above reproach. Coal supply, too, is now-a-days becoming one of those items that are much juggled with, and "normal coal supply" may mean more than one thing. In theory it is the coal carried at the nominal displacement, but the nominal displacement is often very nominal. British ships, too, whatever they may displace, invariably carry what is known as the "maximum capacity." All our big battleships and cruisers of the Diadem class take in up to 2000 tons as a matter of course, though this is, on paper, assumed to be a sort of emergency amount. The Elswick cruisers built for foreign powers have never to our knowledge loaded with the "normal" amount; they usually take a mean between that and the "maximum capacity." The lines of British designs admit of this without much, if any, effect on the speed; the lines of some foreign ships certainly

*It is not certain whether this redoubt will be more than 4 in. thick—some German service papers call it 6 in., others 4 in. The turrets are certainly all of them 6 in. thick, and have been manufactured by Krupp.

will not so easily permit of it. In dealing with coal capacities, therefore, we generally have to deal with a certain amount of the unknown.

Taking these three ships and comparing them, we find that if we arrange them according to their superiority in speed, armament and armor, we get—

Speed.	Offence.	Defence.
Essex.	Prinz Heinrich.	Essex.
Bayan.	{ Essex.	Prinz Heinrich.
Prinz Heinrich.	{ Bayan.	Bayan.

This is very approximate. The only comment to make is that it is highly improbable that the Russians will ever make the Bayan steam so fast as the German ship, in service, the engineering department being the weak point of the Russian navy. On the other hand, our engineers and the Germans are very good.

In offense the Prinz Heinrich is unquestionably first. She is the only ship of the three able to deliver a vital blow. The Essex is sacrificed to a fad about 6-inch guns in this respect.

In defense, the Bayan lacks from, in our opinion, an unnecessary thickness of her belt. She has a protection to her vitals as good or better than that of many battleships. Above, she is not shell-proof. Otherwise, had she had a, say 5-inch belt, and 5-inch, or whatever the equivalent may be, on the redoubts, her defense would have been as good or better than any. We hold that of the Essex better than the Prinz Heinrich's because she does not risk, like that ship, having all her 6-inch put out of action by one big shot.

It is an interesting subject to speculate on, but such speculations must be extremely approximate. The Essex is probably designed with the prime idea of speed, the others with different objects, so that we should be rash indeed to attempt to lay down which is the better ship of the three. What we do chiefly feel is that there is a good deal of room for some ships of both the Prinz Heinrich and Bayan types in our navy—the Bayan especially, as we have nothing at all like her, whereas the Cressy assimilates to the Prinz Heinrich in the matter of carrying armor-piercing guns.—*The Engineer*, Oct. 12, 1900.

BRITISH ARMORED CRUISER ABOUKIR.

A fine example of an armored cruiser of a type now building for the British navy is H. M. S. Aboukir, recently launched from the Fairfield yard at Govan on the Clyde. This vessel is a first-class steel, sheathed, armored cruiser of these dimensions: Length, 445 feet; beam, 69 feet 6 inches; mean draft, 26 feet 3 inches; displacement, about 12,000 tons. The Aboukir will be fitted with twin screws driven by triple-expansion engines, with cylinders 36 inches, 59 inches, and (two) 68 inches diameter, and 4-foot stroke, of 21,000 collective horse-power. Steam will be furnished by thirty Belleville water-tube boilers fitted with economizers arranged in four groups, each group fitted in a separate water-tight compartment. The boiler pressure will be 300 lbs., reduced at the engines to 250 lbs. The estimated speed is 21 knots. For protection the Aboukir will have an armor-belt of 6-inch nickel steel for 230 feet of her length and 11 feet 6 inches deep. Harveyized steel 12 inches thick will be used for the

conning-tower, and the barbettes will be protected with 6-inch armor. Bulkheads will be of 5-inch nickel steel, and the protective deck will have a maximum thickness of 3 inches. The armament will include two 9.2-inch and twelve 6-inch guns, also fourteen 12-pounders, besides several boat, field, machine and automatic guns. There will be two 18-inch submerged torpedo-tubes, fitted broadside. The complement is 750 officers and men.—*Marine Engineering*, Oct., 1900.

THE ARMORED CRUISER JEANNE D'ARC.

The Jeanne d'Arc, which was successfully launched at Toulon on the 8th of June, belongs to the class of armored cruisers, and is in every respect superior to many of the vessels of this type which still figure upon the lists of modern fleets. Her armor is composed of plates of Harveyized steel, the force of resistance of which is much greater than that of the iron plates which protect very many of the armorclads now in service. Her guns, which are of unusual power, are very efficient, as a consequence of the progress made in the manufacture of ordnance. Finally, the Jeanne d'Arc is a very swift vessel, and made 23 knots on her trial trip, say a little more than 25 miles an hour. Perhaps it will be regretted that an attempt has been made to obtain so great a speed, since this has certainly rendered it necessary to sacrifice many things and to surmount great difficulties, by reason of the immense space required by the engines and boilers that are always required in such a case.

This cruiser is not designed to form part of a squadron for war duty, but has a more modest mission, that of protecting maritime commerce, making raids in distant seas, and destroying the enemy's merchant vessels and swift packet boats. In order to do this a vessel must have a high speed, a sufficiently high-power armament, and a wide radius of action, which is equivalent to saying that its coal supply must permit it to make long trips. To solve such a problem is not easy. Whether the Jeanne d'Arc will solve it, it remains for the future to say.

The armored cruiser is in great favor in all navies, and is now taking the place so long occupied by what are called protected cruisers, that is to say, those that are destitute of side armor. About twenty years ago the English constructed a group of five of these, but went no further in this direction. France, in turn, took up the work and produced an excellent ship, the Dupuy de Lôme, which embodies most of the innovations that are now in general use. The Dupuy de Lôme was an admirable vessel, and it would have been necessary only to increase her size in order to improve the type. Her armor was a very prominent feature, and the artillery in turrets was perfectly protected; but the French waver in their ideas, and, instead of improving upon this specimen and giving a wider range of action, they reduced the tonnage, the protection, the speed, and the armament of the vessels that followed. This error led them to add to their navy five inadequate armored cruisers of about 5000 tons, which are neither fleet ships nor ships for a squadron and which are now utilized in any way that may be found possible. With the Jeanne d'Arc, France has taken a new departure and is now constructing twelve cruisers, some of 10,014 tons and others of 9500 and 7700, with a speed of 21 knots.

The Jeanne d'Arc has the following dimensions: Length over all, 477 feet; breadth, 63.75 feet; mean draught, 24.75 feet; displacement, 11,270 tons.

She has two groups of three funnels, two protected conning-towers and two masts. The foremost is provided with a military top equipped with 1½-inch rapid-fire guns, designed to repel the attacks of torpedo-boats. The other mast is to be used only for signals.

The vessel has three screws, each driven by triple-expansion vertical engines, each of which is completely isolated and independent of its neighbors. This is the Depuy de Lôme system, now applied for the first time upon this vessel.

Steam is furnished to the cruiser's engines by tubular boilers of the Guyot type, and belonging to the general type of what are called multi-tubular or aqua-tubular generators, and the water in which passes through the interior of the tubes. The evaporating apparatus is to furnish 28,500 horse-power, although a portion of this will be utilized for running the numerous—too numerous—auxiliary engines that operate upon the vessel. The modern ship is truly a huge workshop, in which the mechanic reigns as master.

For feeding the grates, it is possible to stow away upon the Jeanne d'Arc 2100 tons of coal. This supply, increased by several hundred tons of petroleum, will permit of running 4000 leagues at sea at the low speed of 10 knots; and so the Jeanne d'Arc will be able easily to make a trip to China without a stoppage. In order to protect her, there has been established, according to the French system, an armored belt formed of steel plates of 6-inch thickness that surround the entire loadwater line, and, above this, a thinner protected belt of 3-inch thickness. Finally, the armor ascends toward the front, almost for a third of the length, starting from the stem, thins down to 2¼ inches, and covers the entire height of the hull. Such an arrangement has been devised because in a swift cruiser the front is the part that is most exposed to the fire of the enemy. The protection is completed by two armored decks.

Let us now pass to the ordnance. The armament is composed as follows: Two 7.6-inch guns in turrets; eight 5.6-inch guns in casemates or in sponsons; twelve 4-inch guns in turrets; sixteen 1.6-inch guns upon the bridges; eight 1.3-inch guns upon the upper deck and in the military top; and two submerged torpedo-tubes. The turrets for the 7.6-inch and 4-inch guns are closed and protected with steel, as are also the casemates and sponsons. The small pieces are sheltered behind shields of hardened steel.

By reason of this distribution of her artillery, the Jeanne d'Arc presents three fine lines of fire: the first consisting of her 7.6- and 4-inch guns in turrets; the second of her 5.6-inch guns in protected casemates; and the third, dominating all, of her small 1.6- and 1.3-inch pieces.

Such is the armored cruiser Jeanne d'Arc, which embodies every progress that has been made in the naval art, and in which electricity plays a leading rôle both for the driving of machines and external and internal lighting. Let us add that the vessel will cost a little more than twenty-one million francs. According to the Navy Department, she will not be available for service until toward the end of the year 1901.

For the above particulars we are indebted to *La Nature.*—*Scientific American Supplement*, Nov. 17, 1900.

THE NEW GERMAN CRUISER AMAZONE.

The Amazone is a third-class cruiser of the vedette sort, equivalent to our own Pelorus class. She is spoken of and to some extent is an improved Gefion, but, as the following particulars show, she resembles the prototype in little save armament:

	Gefion.	Amazone.
Displacement, tons	4207	2645
Length, feet	334	328
Beam, feet	42¼	39
Draft, feet	21½	16½
Armor deck, amidships	3 in.	2 in.
" ends	1 in.	1 in.
Armament	Ten 4 in., six 6-pdr., eight machine.	Ten 4 in., ten 3-pdr., eight machine.
Torpedo tubes	Two above water.	One submerged, two above water.
Horse-power, maximum	9828	6600
Speed (maximum), knots	20.5	20
Coal (normal), tons	900	300

The Gefion was launched in 1893; it is interesting, therefore, to note that German ideas, which in the Gefion closely followed ours, have since then branched off in an entirely independent direction. In the Gefion coal is the chief consideration, and the guns are secondary. In the Amazone it is just the other way about. The most she can carry is 500 tons.

However, before discussing the ship at length, it may be interesting to compare her with our similar ships, the Pelorus class. In the connection the Russian Novik, with which we shall be dealing in an early number, may also be introduced, as she represents the same kind of sacrifice as the Amazone, only in her case everything is sacrificed for speed:

	Amazone (German).	Pelorus (British).	Novik (Russian).
Displacement, tons	2645	2135	3000
Length, feet	328	300	361
Beam, feet	39	36¼	39½
Draft, feet	16½	15*	19
Guns	Ten 4 in., ten 3-pdr., eight Maxims.	Eight 4 in., eight 3-pdr., three Maxims.	Six 4.7 in., eight 3-pdr.
Torpedo tubes, submerged	1	0	0
" above water	2	2	6
Armor deck, maximum	2 in.	2 in.	2 in.
Horse-power	6000	7000	17,000
Speed (maximum), knots	20	20	25
Coal (normal), tons	300	250	(?)
Coal (full capacity), tons	500	500	(?)

As the Pelorus is a much smaller ship, her coal supply is proportionately better, nor does she in any way compare badly with the German. It is worthy of note that the Pelorus has 7000 indicated horse-power to make her speed with, while the larger German has to do it with less. Sisters of the Amazone have done their 20 knots on trial, but in a race the honors would undoubtedly go to the Pelorus class.

*15 ft. is the Pelorus' nominal draft, but 17 ft. is probably nearer the actual. The 19 ft. extreme draft to the Novik is doubtful.

To return to describing the Amazone. It will be noted that her guns, as in most German types, are placed with a great regard for end-on fire—the theoretical right-ahead fire being four guns, while the amidship pieces have a very large arc. The Pelorus has but two guns that fire right ahead. Actually the German fire would not exceed three—cases in which both end sponsons could fire at the same ship being chiefly theoretical.

The Amazone is to be fitted with the Schultz boiler, which is an adaptation of the Thornycroft, and resembles it very closely indeed.

The protective deck has a somewhat curious form, various hatchways in it being protected with armored coamings. Amidships, too, the deck, instead of being a mere roof to the engine-room, more or less fits closely upon them, and wherever anything reaches high up the deck is there domed up for it. It is at least ingenious. Altogether about eight ships of the Amazone type are built or building. Those launched and completed or nearly so include the Gazelle, Nymphe and Niobe. Another, the Ariadne, has just been launched. The remaining three are not named as yet. Others appear to be projected.—*The Engineer*, Nov. 2, 1900.

THE GERMAN ARMORED CRUISER PRINZ HEINRICH.

The Prinz Heinrich, at present completing for sea, is apparently intended as a standard type for German armored cruisers. Unlike the Fürst Bismark, she is not a merely weak battleship, but a cruiser pure and simple, built chiefly with an eye to cruiser work.

Her principal dimensions, etc., are as follows:

Displacement	8868 tons.
Length	394 ft.
Beam	65½ ft.
Draft (mean)	23¾ ft.
Armament	Two 9.4 in. (24 cm.).
"	Ten 6 in. (15 cm.).
"	Ten 1-pounders.
"	Four Maxims.
Torpedo tubes	One bow, submerged.
" "	Two broadside, submerged.
" "	One, stern, above water.

The armor is distributed as follows: There is a complete water-line belt of Krupp armor 4 inches to 3 inches in thickness, reinforced by a protective deck 2¾ inches thick on the slopes. Above the belt there is a redoubt about 165 feet long, and of about the same thickness as the belt. Above this again is the main deck redoubt, 6 inches thick, in which six of the 6-inch guns are mounted. Both redoubts have 6-inch bulkheads, while screens will be placed between the guns in the upper one. On top of the upper redoubts there will be four turrets, oval in shape, each 6 inches thick, and carrying a 6-inch gun. Forward and aft are barbettes, each mounting a single 9.4-inch gun, and protected by stout shields. These barbettes will have a total height of about 9 feet, will be 6 inches thick, with armored hoists descending to the protective deck. The conning-tower, which will have a thickness of 6 inches or more, will have an armored tube of communication.

It will be noted that the Prinz Heinrich has little in common with the

Fürst Bismark. The latter has no protection to the lower deck, and has her armament a good deal more distributed. The Prinz Heinrich, on the other hand, is a direct adaptation of the French Brennus, and closely resembles that ship both in the disposition of armament and in the system of armoring. The high forecastle and the bow submerged tube are the only distinctly German features in the design, and there is nothing of the Fürst Bismark about her save in general outline.

Like all German ships, the Prinz Heinrich will have no wood used in her construction, unless the latest discovery, or supposed discovery, that woodless ships are very insanitary, causes some departure from a well-established German custom.

The estimated indicated horse-power is 15,000, which is expected to give a speed of 20 knots. There are three screws, and the deadwood aft is very much cut away after the Elswick model, in order to make the ship relatively handy. This, for a cruiser, she should be, as she has a very fair proportion of beam to length. The boilers selected for her are of the Dürr type.

Comparisons between the Prinz Heinrich and other vessels like her in size and *métier*—the Bayan and the British Essex class—we defer till we have treated this last; but it may be of some interest to compare the Prinz Heinrich of 1900 with the Edgar class of 1890 and the Orlando of 1896, since the armaments in each case are practically identical, though the German 9.4-inch gun is, of course, a far more powerful gun than the old 9.2-inch in the other ships. This, however, is more an accident of date than anything else, and in so far as the modern guns are all heavier, enforces rather than detracts from the point we wish to make—the difference between what was demanded then and now for a ship carrying a more or less standard armament for a first-class cruiser in the way of protection and speed.

	Orlando.	Edgar.	Blake.	P. Heinrich.
Date of launch	1886	1890	1891	1900
Displacement, tons	5700	7700	9000	8868
Length, feet	300	360	375	394
Beam, feet	66	60	65	65½
Draft, feet	26	26	27½	24¾ (mean)
Armor belt, inches	10	Nil	Nil	4
Do., lower deck, inches	Nil	Nil	Nil	4
Do., battery, Q. F., inches.	Nil	6 in. on 4 guns.	6 in. on 4 guns.	6
Do., big guns, inches	4½ in. shields.	4½ in. shields.	4½ in. shields.	6
Do., deck, inches	3	5	5	2¾
I. H. P. *circa*	9000	10,000 to 12,000	20,000	15,000
Speed, trial	18.6 to 19	19.5 to 20	21.5	20 (est.)
Actual sea-speed at a push.	15.5 or less.	19.5	20.5	—

The Orlando, the only cruiser carrying belt armor except the Prinz Heinrich, has less than this ship, and is altogether smaller. She belongs to the era of "paper" ships, and to this day, with her 10-inch "armor belt"—all under the water-line, by the way—and heavy armament, is a grand ship for the makers of statistics. The Prinz Heinrich could probably tackle three of her. The Edgar and Blake are more interesting comparisons. All the class are as good ships as ever were built for speed. Although now nearly ten years old, they are all excellent steamers, and in

the recent maneuvers kept station at 19 knots without the least difficulty. Ten years have seen far less advance in speed than people are prone to imagine. It is exceedingly doubtful whether there is a warship in the world that could beat the Edgar class in a thirty hours' race. The advance of recent years has been in protection, and the problem to-day is to pile on armor without deteriorating the other cruiser essentials. Of course the difference has to be made up somehow. In the case of the Prinz Heinrich coal is probably sacrificed—though, as her capacity has not yet been announced, it is difficult to speak definitely on this point. The greatest point of divergence, however, tends to be in form, and owing to changed lines more speed is got out of a unit of horse-power to-day than in the past. Still this embraces a wide subject hardly to be discussed in this article, the matter being very complicated. As regards its practical results, mere dimensions of the ordinary sort do not go for much. Though the modern cruiser is, as a general rule, longer and proportionately narrower than her predecessors, we now and again find some of the best steamers short, broad ships, comparatively speaking. Of modern cruisers of moderate size nothing in the British navy has beaten the Vindictive class, and these are only 320 feet long, with a breadth of 57½ feet, dimensions very equivalent to those of the Orlando class, displacement and horse-power being also fairly akin. Yet in the one case the ships never could steam fast, while in the other 19 knots is easily maintained at sea in moderately smooth water. Under-water lines and arrangement of weights—both things too elusive for statistics—are, of course, far and away the principal governing factors in these instances.

However, length is the thing that tells directly the sea gets up, and in a seaway the Prinz Heinrich ought to beat any of the older vessels with which we have compared her, about 400 feet being the necessary minimum of length for any cruiser to maintain speed in big waves. If she is much less than 400 feet long she will be going up and down on single waves, and lose speed accordingly. This fact—that ships cannot maintain speed unless long, coupled with the fact that they cannot steer properly unless relatively short—is one of the worst problems that faces the designers of warships. They cannot eat their cake and have it too; hence much variety and the eternal compromise. But since the present trend of ideas is that a speed-keeping cruiser is better than a handy one, more or less long vessels are now the order of the day. Ten years hence the "agile" cruisers may be in favor again, but at the present time cruisers maneuver about as adroitly as elephants.—*The Engineer*, Sept. 21, 1900.

THE JAPANESE BATTLESHIP MIKASA.

Perhaps the most interesting feature in the design of the Mikasa, the Japanese battleship launched by Messrs. Vickers, Sons & Maxim, Limited, at Barrow-in-Furness, on Thursday of last week, is in the distribution of her armor, several modifications in recent practice having been made in the design. In giving a brief description we, therefore, give first consideration to this. As in the two earlier Japanese battleships built in this country, the Asahi and Hatsuse, the water-line armor belt extends from end to end, instead of terminating at the ends of the citadel, and thereby leaving about 80 feet from the stern unprotected. The main belt has a width of 7 feet 9 inches, of which 5 feet 3 inches is below the

water-line. The main belt armor in the way of the citadel, for 156 feet in length, is 9 inches in thickness, beyond this at either end—to some distance past the forward and aft 12-inch armored transverse bulkheads—it is 7 inches in thickness, assisted by additional 1½-inch nickel-steel plates placed on the slope of the protective deck, so as to make the resistance equivalent to 9-inch Krupp-Harveyed armor, for the whole length of the citadel and barbettes. From the ends of this 7-inch belt to the ends of the ship the armor is 5½ inches and 4 inches in thickness. Athwartship bulkhead of 6-inch armor is fitted at the after extremity of the water-line belt to afford protection against raking shot. On the advice of the Vickers Company, the Japanese government, with their characteristic progressive tendency, have introduced in the Mikasa a departure which must be of interest to all naval constructors, the effect being to increase the area of the armored broadside. Above the main armor, and extending for the whole length of the citadel, there is 6-inch armor up to the level of the upper deck, instead of to the main deck as in previous ships, so that the total width is 21 feet 6 inches for the length of the citadel, and 7 feet 9 inches forward and abaft it.

The two barbettes are 14 inches in thickness, reduced to 10 inches where protected by 6-inch citadel armor; while the guns are protected by armored shields. The conning-tower is of 14-inch armor, the screens being 12 inches. The whole of the armor, it is almost needless to say, is constructed on the Krupp principle, and is of a nickel-steel alloy.

The extension of the main belt to the upper, instead of to the main, deck as in preceding ships, dispenses with the necessity for casemates for the 6-inch guns on the main deck; but to insure the same measure of isolation for the ten 6-inch quick-firing guns placed on this deck, as is obtained by the casemate system, bulkheads are placed between the guns, while an armored screen extends the whole length of the citadel behind the guns. These divisional bulkheads and the armored screen are of hardened steel—sufficient to insure that the splinters of any shell which may explode in one compartment will not affect either the gun or gunners in the adjoining compartment. The 6-inch guns on the upper deck, four in number, are within 6-inch casemates.

The protective deck is of a minimum thickness of 2 inches, and extends over the full length of the ship; but is increased to 3 inches on the sloping parts within the citadel, and to 4½ inches in thickness in the wake of the barbettes as before mentioned. In addition to this, the upper deck within the citadel is made of 1-inch plates. As usual, there is an ammunition passage under the protective deck with communication, through ammunition tubes, to the various gun positions; while coal-bunkers are arranged above and below the protective deck from end to end of the citadel. There is thus an increased broadside protection to the citadel, as well as in the ends of the ship.

The general dimensions of the Mikasa do not differ materially from those of the British battleships of recent type. The ships of the Majestic and Canopus class were 390 feet long; the Formidable, 400 feet long; and the Duncan 405 feet long—all between perpendiculars. The Mikasa is 400 feet, the length over all being 432 feet. The breadth moulded is 76 feet in the Mikasa, as compared with 75 feet 6 inches in the Duncan, and 75 feet in the Formidable and Majestic. The draft is 27 feet 2 inches, and at this the displacement will be about 15,200 tons.

Like the two preceding ships for the Japanese navy built in this country

—the Asahi and the Hatsuse—the Mikasa carries four 12-inch breech-loading guns fitted in pairs in the two barbettes on the upper deck, and fourteen 6-inch quick-firers, four placed, as already indicated, within casemates situated on the upper deck at the corners of the citadel, the remaining ten 6-inch guns being placed in the box batteries on the main deck. The auxiliary armament of the ships consists of twenty 12-pounder quick-firing guns, four firing ahead and four astern, the remainder being on the broadsides; eight 3-pounder quick-firing guns and four 2½-pounder quick-firing guns. There are four submerged torpedo-tubes, two in the forward part of the ship and two aft.

The general appearance of the battleship is indicated by the elevation which we publish, and it need only be added that in her electric and compressed air equipment she embodies the best modern practice, the lighting installation including 900 incandescent lamps, with masthead, bow, anchor and other special lights and also six searchlights. The ship will be fitted as a flagship, accommodation being provided for an admiral and 78 officers, the total complement being 935 all told.

The Mikasa is to have a speed of 18 knots under natural draught, and will have a coal capacity of 1400 tons, to give her a radius of action of 9000 sea miles at 10 knots speed. The engines are of the triple-expansion 3-cylinder type, the diameters of the cylinders being 31 inches, 50 inches and 82 inches respectively, the stroke being 48 inches; and it is anticipated that the full power of 15,000 indicated horse-power will be developed with the engines running at 120 revolutions per minute, the steam pressure at the engines being 250 lbs., and at the boilers 300 lbs. Stephenson link motion is adopted for working the valves, which are of the piston type on the high-pressure and intermediate cylinders, and of the double-ported flat design on the low-pressure cylinders. The engines, as with all warships now, are designed to run the propellers inwards when going ahead, so that the starting platform is in the center of the ship, and here, as is now the universal practice, wrought-steel columns form the front supports of the cylinders which are independent castings. The back supports of the cylinders are of the ordinary cast-iron A-framing, with ample slipper guide surface. The condensers are separate, and placed in the wings of the ship. The total cooling surface is 16,014 square feet.

The bedplate is of cast steel. The working parts of the engine generally are of forged steel, but the crankshaft is of nickel steel, the three parts being interchangeable. The external diameter is 16¼ inches, with an 8¼-inch hole. The propeller shaft is of wrought steel 16½ inches in diameter, with 8½-inch hole, while the propellers have four blades, the diameter being 17 feet, and the mean pitch 18 feet. The four blades and the boss are of manganese bronze.

The boilers are of the Belleville type, with economizers. There are 25 in all, of which 20 consist of eight elements of generating tubes and seven elements of economizer tubes; while the remaining five boilers have seven elements of heating and six elements of economizer tubes. The total heating surface is 37,452 square feet, and the grate area 1276 square feet. The two funnels are 14 feet in diameter over the casings, the height from the firegrate being 91 feet. There is the usual complete system of pumps, with blowing engines for the furnaces. The total weight of the machinery is 1355 tons. The machinery is practically completed and ready to be placed on board the ship, which is to be completed for sea in May of next year.—*Engineering*, Nov. 16, 1900.

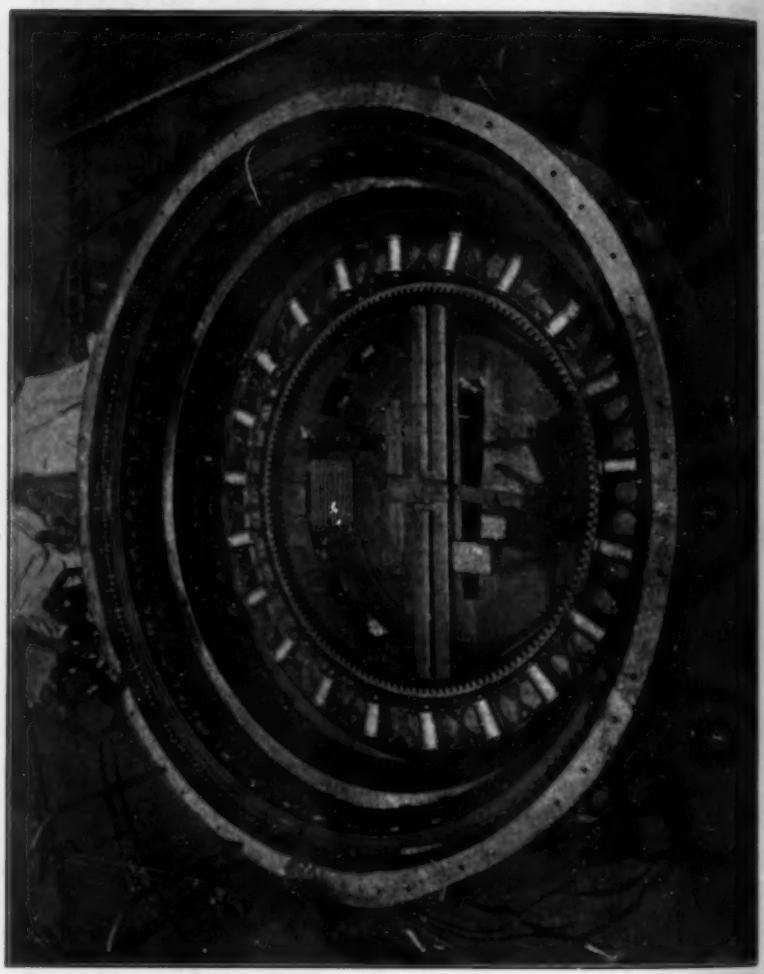
THE FIRST-CLASS BATTLESHIP ALABAMA.

The Alabama, whose record of 17 knots an hour on her recent official trip, places her at the front rank of our battleships for speed, will always be a vessel of particular interest, from the fact that in her we see the introduction of a new type in the United States navy. Comparing her with the Oregon, the Iowa or the Kearsarge, the most noticeable difference is the entire absence of the 8-inch gun. Hitherto our battleships have been distinguished from those of other navies largely by the fact that they carried a much heavier armament, due chiefly to the presence on board of a complete battery of guns which were intermediate in power between the main battery of 12-inch and 13-inch guns, and the secondary battery of rapid-fire guns of 5-inch and 6-inch caliber. The battleships of Great Britain, France and Germany, and with a few exceptions of Russia, have carried no guns of a caliber between the 12-inch and the 6-inch weapons, and in the Alabama we see the first disposition on the part of our naval constructors to follow the European practice. Although the absence of the 8-inch gun is very sincerely regretted by most of our officers of the line, it cannot be denied that in the Alabama the heavy secondary battery of 6-inch guns, on account of its rapidity of fire and the enormous weight of metal which can be thrown in a specified time, goes far to offset the removal of the very popular 8-inch breech-loading rifle.

The Alabama was authorized June 10, 1896; the contract for her construction by the William Cramp & Sons Ship and Engine Building Company was signed the following September; the keel was laid the December of the same year, and the vessel was launched on May 18, 1898, and has now been completed about eleven months later than the contract date, the delay being due to the failure of the builders, on account of the armor-plate controversy, to receive the necessary armor during the construction of the ship. The vessel is 360 feet long, 72 feet 2½ inches broad, and has a mean draft, when fully equipped for sea, and with 800 tons of coal on board, of 23 feet 6 inches. Her displacement on the draft given is 11,565 tons. She is driven by twin-screw, vertical, triple-expansion engines, and steam is supplied by boilers of the Scotch type. Her normal coal supply is 800 tons and her bunker capacity with nominal loose stowage is 1200 tons, while with close stowage she can hold 1440 tons in the bunkers. As compared with the Kentucky and Kearsarge, she has about 8 feet more freeboard, due to a spar deck which extends from the bow about two-thirds of the way out. Her protection consists of a belt of Harveyized armor of a maximum thickness of 16½ inches, which tapers toward the bow and stern. Above the belt, amidships, side armor of 6 inches is carried up to inclose and protect the guns of the secondary battery. The main battery of four 13-inch guns is carried in elliptical balanced turrets which have 14 inches of armor protection. The secondary battery is extremely powerful and consists of fourteen 6-inch rapid-fire guns, twelve of which are carried on the main deck and two on the boat deck amidships. She is also armored with sixteen 6-pounders, six 1-pounders, four Colts, and two 3-inch field guns. She is fitted with four tubes for the discharge of Whitehead torpedoes.

In various articles on naval matters which have appeared from time to time in the *Scientific American*, we have described and illustrated, with sectional views, the structural features of the barbette of a modern war-

ship; but we think that the most knowing of the naval "sharps" among our readers will be able to learn something from the accompanying illustration showing the interior of a barbette before the turret was installed. The photograph from which our plate was made is one of a series of



INTERIOR OF THE BARBETTE OF THE FIRST-CLASS BATTLESHIP ALABAMA.

photographs which were filed with the Chief Constructor of the Navy during the construction of the Alabama. It was taken from the after end of the superstructure, the deck upon which the people around the edge of the barbette are standing being the main deck.

The barbette is a vertical, cylindrical, heavily armored redoubt, which extends from the protective deck to a height of 3 feet 8 inches above the main deck. The duty of this redoubt is to protect the unarmored base

of the turret, the mechanism by which it is rotated, and the hoist by which the ammunition is brought up to the guns. Within this cylinder, which is about 12½ feet in depth, is located a circular track upon which is a circle of twenty-one conical rollers, which are held in their proper spacing and radial position by means of two concentric rings, firmly braced together, as clearly seen in the illustration. Upon these rollers is carried the whole weight of the turret, the guns and their mounts, a total of 277 tons. The lower half of the turret is in the form of a circular-inverted cone and is unarmored; the upper and armored portion of the turret is elliptical in plan, and the rear portion of it projects over the top edge of the barbette, enough space being left between the turret and barbette for easy clearance in turning.

The barbette is protected for two-thirds of its circumference with 14 inches of Harveyized armor, the remaining one-third, or the portion which is nearest to the point of view from which the photograph was taken, is protected with 10 inches of armor, less protection being needed on this portion of the barbette because it is screened by the 6-inch side armor on the hull of the vessel. The armor is bolted to a backing of teak, within which is 1 inch of steel plating attached to a heavy framing of steel beams, angles and channel beams. The internal diameter of the barbette is 27 feet.

Immediately within and below the circle of rollers is seen the massive circular rack which forms part of the turning mechanism of the turret, rotation being effected by means of two electric motors carried in the base of the turret. The shafts of these motors are connected by suitable gearing with pinions which engage the circular rack; and the training of the great weight of the turret and guns is accomplished with a speed and accuracy which are impossible when hydraulic, compressed air, or steam motors are used.

The after barbette of the Alabama contains altogether 26 tons of armor. The total weight of the installment, including turrets and guns, is 783 tons. The forward barbette and turret, however, are much heavier, the total weight in this case being 978 tons. This increase is due to the fact that the Alabama carries her forward guns above the spar deck, and, therefore, some 7½ feet to 8 feet higher above the water-line than the after pair of guns, the increase in weight being due entirely to the increased height of the barbette.—*Scientific American*, Sept. 8, 1900.

THE NEW BATTLESHIPS.

The *Scientific American* published, in its issue of June 9 last, an illustration and description of the three battleships then designated Georgia, Pennsylvania and New Jersey. Some time later, after the report of a special board, the Navy Department assigned those names to the three ships that are to carry superposed turrets, while the two vessels appropriated for by the last session of Congress, bearing the names of Virginia and Rhode Island, will be as described and pictured in our issue of last June.

Without going into the merits of the case, the majority decision of the special board in favor of arming three of the five new battleships with superposed turrets followed directly upon the final acceptance trials of the Kearsarge. The object of the board's being was the determining of

the better type of ship, all five, of course, to be alike, and the decision or recommendation showed the board to be hesitating in judgment. The result is to miss the prime opportunity of fashioning five ships of absolute similarity, a feature of fighting efficiency in combined operations hardly to be overvalued.

In general dimensions, these ships will be like those described previously. They will have a load-water-line length of 435 feet; an extreme beam of 76 feet 10 inches; a trial displacement of 15,000 tons; a mean draft at trial displacement of 24 feet; a greatest draught, full load, of 26 feet; a total coal-bunker capacity of 1900 tons; and a trial speed of 19 knots.

The most important difference in hull between these ships and the two of later appropriation is in the wood-sheathing and coppering which these ships will receive. Throughout the bottom and bilges and up to a height of three or four feet above the water-line there will be a thick covering of fine pine carefully tapped to the underlying metallic skin and rendered water-tight and non-galvanic. Over this will be laid the copper. The advantages of this system are too well known to need explanation here; and, in consequence, the ships will prove far more economical in their consumption of coal, readier at all times for high-power service, and able to maintain their speed even after months in the fouling waters of the tropics. Such of our sheathed and coppered craft as have done service in the Far East have proved valuable practical examples of the advantages of this system of bottom protection.

In hull form there will be a novelty, common to all five of the new battleships, in the way the uniform freeboard of 20 feet is maintained from bow to stern. Apart from the military advantage gained in the added height of the guns of the main battery aft, there will be a net gain in accommodations of infinite comfort and healthfulness to both officers and crew. None of them will be shut up behind the blank walls of heavy armor, as heretofore, lighted only by artificial means, but the living spaces will all have air ports and direct access to sunlight. This added freeboard aft, too, will make the ships more weatherly in a following sea.

The armor protection to the hull will consist primarily of an 8-foot water-line belt, 5 feet of which will be below water at load draft. The maximum thickness of this belt is maintained amidships for a distance of 192 feet abreast the engines and boilers. From the top downward 5 feet, this armor will be 11 inches through, and thence to the armor shelf will taper to 8 inches. The belt is continuous from bow to stern in varying thicknesses. For a distance of 60 feet forward and 32 feet abaft the central portion, the plates are to have a maximum thickness of 9 inches and a minimum of 6, the maximum 9 inches ranging downward 5 feet. For a distance of 16½ feet forward and aft, the next course of armor will have a greatest thickness of 6 inches and a least thickness of 4½, the limits of dimensions, as in all following cases, being similar to those in the portions already described. Seventeen feet forward and aft, next, the armor will have a maximum thickness of 5 inches and a minimum of 4, while the remaining armor, running forward to the bow and aft to the stern, will have a uniform thickness of 4 inches. This armor will be treated by the Krupp process.

Above the main belt, for a distance of 245 feet amidships, *i. e.*, throughout the position of the main broadside rapid-fire battery of 6-inch guns, the sides will be reinforced by armor of a uniform thickness of 6 inches.

This armor will reach all the way up to the main deck, and it will be joined to the barbettes of the 12-inch turrets by athwartship armor of 6 inches in thickness aft, and by inclined armor of like thickness forward, yielding, in this latter case, the added protection of glacis against the head-on raking fire of an enemy. The after athwartship armor is vertical.

There will be a curved protective deck, reaching from bow to stern, being 1½ inches thick on the flat and 3 inches thick on the slopes. A cellulose belt 3 feet in thickness will be worked continuously from bow to stern along the sides above the protective deck. The obturating material will be the well-known cornpith cellulose.

Wood will be used very sparingly, and, where indispensable and not exposed either to the weather or under water, will be fire-proofed. Light metal bulkheads will supplant the usual wooden partitions in the living spaces, some of the furniture will be of pressed metal, the chart-house will be of bronze, and all of the decks under cover will be laid with linoleum. To guard against the overheating of the magazines, there will be a 4-inch air space around them in addition to a coating of some non-conducting material, while certain of the magazines are to be arranged so that they may be chilled by compressed air from the refrigerating plant.

Each ship will be fitted as a flagship, and accommodations will be provided for 1 flag officer, 1 commanding officer, 1 chief of staff, 20 ward-room officers, 12 junior officers, 10 warrant officers, and 658 seamen and marines; a total complement of 703 persons.

The refrigerating plant on each ship will have a cooling equivalent of two tons of ice daily; and a steam laundry, capable of handling the clothes of seventy-five persons per diem, will do most of the washing and ironing for officers and enlisted men.

The fighting powers of the vessels will be centered in the main battery of four 12-inch and eight 8-inch breech-loading rifles, the main rapid-fire battery of twelve 6-inch breech-loading rifles, the secondary rapid-fire battery of twelve 14-pounders and a dozen 3-pounders, and the auxiliary battery of eight 1-pounders, two field pieces, two machine guns, and a half-dozen 0.3 automatic guns.

The four 12-inch rifles will be mounted in two elliptical, balanced turrets 10 inches thick except for the slanting port plates an inch heavier. These guns will fire through arcs of 270 degrees. Four of the 8-inch guns will be superposed upon these turrets, fixed to move in unison, and they will be sheltered by walls of 6-inch armor increased half an inch on the slanting face plates. The four remaining 8-inch guns will be mounted amidships, two on each side, on the main deck, and will be housed in independent turrets similar to those placed above the 12-inch guns. These 8-inch rifles will have arcs of fire of 180 degrees, ranging from dead ahead to dead astern. This arrangement of the 12- and 8-inch guns gives a bow and a stern fire of six 8's and two 12's, and a broadside of six 8's and four 12's.

The 6-inch guns are arranged in broadside similarly to the ships previously shown last June. Each 6-inch gun, of which there are six on each broadside, has an arc of fire of 110 degrees, and the ports are so arranged that the guns can be turned inboard within the side line, the guns swinging toward one another in pairs; beginning forward, the first gun turns aft while the next one swings its muzzle forward, etc., to the after pair. This arrangement does away with the inconvenience of dismounting the

guns to avoid obstructions or to guard them against the stress of heavy weather. Each of these guns is sheltered behind a heavy port shield, and there is a splinter bulkhead of 2½-inch nickel steel between each gun and its neighbor on either side. The 14-pounders, sheltered by local armor of 2-inch steel and shields, are to be mounted on the gun deck well forward and aft, and up in the superstructure on the main deck, forward and aft of the amidship 8-inch turrets. The twelve 3-pounders are to be mounted on the bridges and on the superstructure deck, while the 1-pounders, automatic and otherwise, and the Gatlings, are to be placed in the tops and in the boats.

The submerged torpedo-tubes, of which there are two, are to be placed, one on each side, well forward, and the operator is to control his tube from an armored station on the deck above, sufficiently sheltered to be proof against 6-pounder fire.

The rates of fire given previously for the two other battleships apply in the case of these vessels and will be as follows: With ammunition supplied as fast as the electrical hoists can bring it to the guns, the 12-inch guns will fire once in every 1½ minutes; the 8-inch guns once in every 50 seconds; and the 6-inch guns three times a minute.

The motive engines will be of the four-cylinder triple-expansion type, actuating twin screws, and capable of developing 19,000 indicated horsepower. The steam pressure will be 250 pounds, the stroke four feet, and the cylinders will be, H. P. 35 inches, I. P. 57 inches, and two L. P. each of 66 inches. Number of revolutions a minute, 120.

There will be twenty-four boilers of the straight water-tube type, placed in six water-tight compartments. They will have quite 1280 square feet of grate and 55,000 square feet of heating surface. The air pressure in the ash-pits will not exceed one inch of water. On trial, the ships will carry only 900 tons of coal, and a reserve of 66 tons of fresh water will be carried either in tanks or in the double bottom during that time. As originally contemplated, one 50-foot steam-cutter or picket-boat was to have been carried by each ship, but since the report of captains of the attacking fleet during the recent maneuvers at Newport, it is highly probable that each ship will be given two for vidette service against torpedo-boats or submarine craft.

Each ship will carry quite 570 tons of offensive ammunition, not counting torpedo outfit.

Thirty-six months is the maximum time allowed for the building of each ship, and the limit of cost is $3,600,000, exclusive of armor and armament.

These ships were authorized by the act of Congress approved March 3, 1899.—*Scientific American*, Nov. 17, 1900.

THE NEW ARMORED CRUISERS OF THE CALIFORNIA AND MARYLAND TYPES.

No feature of our latest naval programme shows more forcibly the impress of the lessons learned by our late war with Spain than the new armored cruisers now nearly ready for the bidding contractors. Our new battleships are typically fine craft and thoroughly up to date; but it is the armored cruiser that marks most sharply the pace we have cut out for ourselves. The armored cruiser, besides being the eyes and ears

of the fleet, will take its place if need be in the line of battle. The New York was an advance upon her British prototype; the Brooklyn was an improvement; but the California and her class are really second-class battleships with armored-cruiser speed, any one of which against the combined batteries now on the New York and Brooklyn could hold its own with a very fair prospect of giving the two other ships a pretty bad drubbing. Such is the rapid rate of naval development to-day. The six ships in question were provided for by the acts of Congress of March 3, 1899, and June 7, 1900, respectively, three ships being appropriated for at each time; and those of the earlier act are required to be sheathed and coppered, while the last three allowed for were not so specified. Should authority be given to sheathe and copper the latter vessels, the contractors must stand ready to do so.

The general dimensions of the sheathed and coppered ships are as follows:

Length on load water-line	502 feet.
Beam, extreme, at load water-line	70 "
Trial displacement, about	13,800 tons.
Mean draft at at trial displacement, about	24 feet 6 inches.
Greatest draft, full load	26 " 6 "
Coal carried on trial	900 tons.
Total coal bunker capacity	2,000 "
Feed water carried on trial	75 "
Speed not less than	22 knots.
Maximum indicated horse-power	23,000

The only dimensional particulars in which the unsheathed ships will differ from the others are a maximum beam six inches less and a lighter trial displacement by 400 tons; in other respects they are alike.

The ships will have the usual extensive bulkhead system and close water-tight subdivisioning common to all modern fighting ships, and the double bottom will be so arranged that a reserve supply of fresh water may be carried there. The ships will have both docking and bilge keels. The main deck will be the only wooden deck, the others being laid with linoleum; and the use of wood will be restricted to the last degree, all of that within the vessels being fire-proofed.

The fighting positions and the "vitals" will all of them be sheltered behind walls of Kruppized steel, and the arrangement of armor protection will be as follows: First, a water-line belt 7 feet 6 inches wide extending from bow to stern. The belt carries its maximum thickness 4½ feet from the top down, whence it tapers to the armor ledge. For a distance of 244 feet amidships, the armor will have a maximum thickness of 6 inches and a minimum of 5; thence to the bow and to the stern the belt will have a uniform thickness, top and bottom, of 3½ inches. For a distance of 232 feet amidships, above the water-line belt and up to the main deck, the sides will be reinforced by 5-inch armor; transverse bulkheads, turning inboard at the ends of this side armor, will complete the central casemate housing the ten 6-inch guns. These transverse bulkheads will be 4 inches thick. The protective deck will be continuous from bow to stern; on the flat it will be 1½ inch thick and on the slopes 4 inches thick. Above this protective deck a cellulose belt 3 feet thick will be worked along the sides from one end of the ship to the other. It is required that the water-line armor belt be so placed that at least a foot of it will be out of water at deepest draft.

The armament will consist of: A main battery of four 45-caliber, 8-inch breech-loading rifles and fourteen 50-caliber, 6-inch breech-loading rifles; and a secondary battery of eighteen 14-pounders, twelve 3-pounders, four 1-pounder automatic guns, four 1-pounder single-shot guns, two 3-inch field guns, two machine guns, and a half a dozen small caliber pieces for boat service. There will be two submerged torpedo-tubes, to be placed on the broadsides pretty well forward. The 8-inch guns are to be mounted in two balanced elliptical turrets on the main deck forward and aft of the superstructure. These turrets will be generally 6 inches thick with slanting faces ½ inch thicker. The turrets are to be controlled electrically, and are to fire through arcs of 270 degrees. The rate of ammunition supply is one complete round of powder and projectile to each electric hoist every fifty seconds.

The four 6-inch guns mounted on the main deck are to be placed in sponsons at the four main corners of the superstructure, and are to fire through arcs of 145 degrees—the forward ones from dead ahead aft, and the after ones from dead astern forward. These guns are protected by 5-inch armor. The ten other 6-inch guns, five on each broadside, are to be placed amidships on the gun deck—the forward ones firing dead ahead, while all the other guns on each side will have arcs of fire of 110 degrees, and will be arranged to house within the side line. These guns will be separated by 2¼-inch splinter bulkheads. The ammunition hoists will be run by electricity, and are to supply each 6-inch gun with three complete rounds every minute. The 14-pounders will be mounted on the gun deck and up in the superstructure, two forward and three aft of the 6-inch battery on each side, and four on each broadside between the 6-inch guns up in the superstructure. The 3-pounders are to be mounted on the superstructure deck and on the bridges, while most of the 1-pounders are to fill the military tops. Each 14-pounder is to be supplied six rounds a minute, while the 3-pounders are to have ten.

The firing stations for the torpedoes will be sheltered from the reach of 6-pounders and lighter pieces, and are to be located above the torpedo-tubes. The conning-tower, located at the fore end of the superstructure, will be of steel 9 inches thick, and the signal tower, located at the after end of the superstructure, will be of steel five inches thick. The pilot-house will be of bronze. All magazines are to be carefully insulated, and certain of them are to be chilled by the refrigerating plant. All are also to be easily susceptible of instant flooding.

Because of the extensive application of electricity, the ships will carry pretty large generating plants, having a total output from the seven units of 6250 amperes at 80 volts—power enough to run all the ammunition hoists, work the turrets, drive some of the ventilating fans, run the machine shop, and furnish power for the steam laundry which is to do the major share of the officers' and crew's washing. Owing to the high free-board of the ships and to the fact that it is carried uniformly from bow to stern, very excellent accommodations will be provided for the officers and enlisted men, of which the complement will consist of: 1 flag officer, 1 commanding officer, 1 chief of staff, 20 ward-room officers, 12 junior officers, 10 warrant officers, and 777 enlisted men, a total of 822 persons.

The ships will have twin screws, driven each by its own triple-expansion engine of the four-cylinder type. The high-pressure cylinders will be 36 inches in diameter, the intermediate-pressure cylinders will be 59½ inches in diameter, and the two low-pressure cylinders of each engine

will be 69 inches in diameter. They will have a common stroke of 45 inches, and the engines will make about 133 revolutions when developing the maximum indicated horse-power of 23,000. Steam will be supplied by 30 boilers of the straight-tube water-tube type placed in 8 water-tight compartments. They will have a combined grate surface of at least 1590 square feet and a total heating surface of quite 68,000 square feet. The four funnels will rise 100 feet above the grate bars. The normal reserve of fresh water will be 150 tons—just half of that carried on trial, and, excepting coal, the trial displacement will call for two-thirds of all other stores.

The ships will carry ammunition enough to put up a good long fight; 500 rounds being allowed the 8-inch guns, 2800 rounds for the 6-inch guns, 4500 rounds for the 14-pounders, 6000 rounds for the 3-pounders, and a pretty liberal supply for the rest. Provision is to be made for closing many of the water-tight doors automatically, *i. e.*, from a single controlling station, and every care has been taken to minimize the consequences of accident or injury. Three years is the maximum time limit for the construction, and the maximum limit of cost is $4,000,000 in the case of the ships of 1899 and $4,250,000 in the case of the ships provided for during the present year.

We have ample reason to be proud of these latest products of our naval designers; and in either peace or war they are bound to command a wholesome respect.—*Scientific American*, Dec. 1, 1900.

LAUNCH OF THE MONITOR WYOMING.

The Wyoming was launched at the Union Iron Works, San Francisco, on September 8, in the presence of His Excellency the Governor of Wyoming and an enormous crowd of spectators. While a powerful vessel, the Wyoming is considerably less in dimensions compared with the Monterey, though both are practically of the same type. The Monterey is 255 feet in length, and is 59 feet beam, with a depth of 14 feet 10 inches. The Wyoming's dimensions are: Length, 252 feet; beam, 50 feet; and mean draught, 12 feet 6 inches. The side armor of the former vessel is 13 inches in greatest thickness, tapering to 8 inches at the ends; of the latter, 11 inches, tapering to 3 and 5 inches. Displacement: Monterey, 4084; Wyoming, 3235; horse-power engines, 5244 and 2400 respectively; speed, 13.6 and 12.

The armament of the Monterey consists of two 12-inch and two 10-inch main battery, six 6-pounders, four 1-pounders, two Gatlings. Of the Wyoming, two 12-inch, four 4-inch rapid-fire, two 6-pound semi-automatic, four 1-pound automatic, and additional four automatic 1-pounders have been authorized.

Although the Wyoming will carry only two heavy guns, as compared with four carried by the Monterey, the increased power of her two 12-inch rifles, due to greater length and smokeless powder, is such that one round from them will have 12,800 foot-tons more energy than one round from the four guns of the larger vessel.

The keel of the new monitor was laid in October, 1899, and her completion is promised in six months.—*Scientific American*, Oct. 13, 1900.

THE PROTECTED CRUISERS OF THE ST. LOUIS CLASS.

A point has been reached in the development of the new United States navy in which we not only have ceased to follow the lead of other navies, but are producing original designs of ships and novel details which are being followed by foreign constructors. It is true that in size the United States navy stands fourth among those of the world, but in design, material, equipment and efficiency it is the equal, if not the superior, of any other navy. This result is due largely to the ability and energy of the Bureau of Construction and Repair, which, under the Chief Constructor, Rear-Admiral Philip Hichborn, has been responsible for the design, construction and maintenance in a state of efficiency of our new navy. The latest products of this Bureau are fourteen vessels, whose construction has recently been authorized, namely, five battleships, of about 15,000 tons displacement, six armored cruisers of about 14,000 tons displacement, and the three protected cruisers which form the subject of the present article, of a little under 10,000 tons displacement.

The protected cruisers, to be named the St. Louis, Milwaukee and Charleston (the latter to continue the name of the 3700-ton vessel wrecked November 2, 1899, off Kamiguin Island in the Philippine group), compare favorably with their class in other navies. In fact, so closely do they approach the type of second-class armored cruisers that they might easily be mistaken for such. In an engagement they would prove themselves a match for some of the armored cruisers of other navies. A comparison of their principal data with that of the British Monmouth class will demonstrate their value.

	United States.	Great Britain.
	St. Louis, Milwaukee, Charleston.	Monmouth, Essex, Kent, Bedford.
Length on load water-line	424 feet.	440 feet.
Breadth, extreme	66 feet.	66 feet.
Trial displacement	9,700 tons.	9,800 tons.
Mean draft at normal displacement	23 feet 6 inches.	24 feet 6 inches.
Engines, twin-screw, I. H. P.	21,000	22,000
Speed	22 knots.	23 knots.
Normal coal supply	650 tons.	800 tons.
Coal bunker capacity	1,500 tons.	1,600 tons.
ARMAMENT.		
Fourteen 6-inch R. F. guns.		Four 6-inch R. F. gun, in turrets.
Eighteen 14-pdr. R. F. guns.		Ten 6-inch R. F. guns in casemates.
Twelve 3-pdr. R. F. guns.		Ten 12-pdr. R. F. guns.
Four 1-pdr. automatic.		Three 3-pdr. R. F. guns.
Eight 1-pdr. R. F. guns.		Eight machine guns.
Two 3-inch R. F. field guns.		
Two machine guns, 0.30 caliber.		
Eight automatic guns, 0.30 caliber.		
PROTECTION.		
Main side armor	4 inches.	4 inches, tapering to 2 inches at bow.
Lower casemate armor	4 "	
Upper " "	4 "	
6-inch gun protection	4 "	4 inches.
Conning tower and shield	5 "	
Signal tower	4 "	
Splinter bulkheads	2 "	
Protective deck	2½ "	Two decks, 1½ inches and ¾ inch.

The act authorizing the St. Louis class states that these vessels shall carry "the most powerful ordnance for vessels of their class, and have the highest speed compatible with good cruising qualities and great radius of action"; all these qualifications have been embodied in the design for these vessels.

The main deck of these cruisers is supplemented amidships with a covered superstructure, within which are located four 6-inch rapid-fire guns and six 14-pounder rapid-fire guns; outside the superstructure are two more 6-inch rapid-fire guns, located on the center line, one forward and the other aft. Located on the gun deck is the greater portion of the battery, consisting of eight 6-inch rapid-fire guns, twelve 14-pounder rapid-fire guns, and four 1-pounder rapid-fire guns. Sixteen rapid-fire guns are stationed on the superstructure deck and bridges, and the remainder of the battery is located in the fighting tops of the two military masts. Additional platforms are built upon the masts to accommodate the two searchlights. Electric ammunition hoists are designed to supply the guns with the greatest rapidity, making it possible to hurl against an enemy a broadside of about twelve tons of metal per minute.

The four lofty smokestacks, extending to a height of 76 feet 6 inches above the normal load water-line, provide draft for sixteen straight water tubular boilers located in four water-tight compartments, which, together with the engines, are protected by the side armor, sloping deck armor, and a 12-foot coal-bunker.

The inner bottom of these vessels extends to the under side of the protective deck; above the protective deck a cellulose cofferdam, 30 inches wide and 41 inches above the normal load water-line, extends throughout the length of the vessel.

In the construction and equipment of the St. Louis class, as small a quantity as possible of wood is to be used, and wherever it is used it will be electric fire-proofed. Each vessel of this class is fitted to accommodate a flag officer and staff in conjunction with the regular complement. In commission the number of officers will be 39 and the crew will number 525 men, for which are provided 16 boats, ranging from a 36-foot steam cutter to a 16-foot dinghy, and in addition to these two 12-foot punts and two life-rafts will be carried. These boats are stowed in chocks on the superstructure deck and swung out by four cranes.

All the latest and best improvements in construction and equipment are to be provided for the accommodation and comfort of the officers and crew.

The water-line belt, 4 inches in thickness, extends in the wake of the engines and boilers and magazines for over one-third of the vessel's length, and reaches from several feet below to about 3 feet above the normal water-line. Side armor of the same thickness is carried up amidships to the main deck, and extends between and includes the forward and after 6-inch guns on the gun deck. The 6-inch guns at the four corners of the superstructure are also protected by 4-inch armor.

While we greatly admire these vessels, we must express a regret that the water-line armor was not carried up to the bow, even if some compromise had been necessary in the matter of coal or armament. This is an age of armored cruisers (*i. e.*, ships with a complete water-line belt), and it is regrettable that these vessels should fall short of the requirements for want of the 120 feet of 2- to 3-inch armor necessary to complete the belt to the stem.

The corn-pith cellulose cofferdam at the water-line, with its water-excluding properties, will safeguard the trim and stability of the St. Louis against all but the smaller 6- and 14-pounder shells about as effectively as if the 2-inch belt were extended to the stem; but it will be just these very small caliber guns that will be used to search out and cut to pieces the unprotected ends of an enemy's water-line.

It must be admitted that the new ships, although they are not quite in the class of the armored cruisers, are nevertheless more than a match for any protected cruiser afloat.—*Scientific American*, Dec. 22, 1900.

THE FIRST-CLASS BATTLESHIP WISCONSIN.

The first-class battleship Wisconsin, recently completed by the Union Iron Works, possesses interest for our readers from the fact that she was built in the yard which turned out the famous battleship Oregon. The latter vessel, like the Wisconsin, is one of a class of three ships, and like her she is the fastest in her class. The Alabama, the Illinois and Wisconsin were authorized on June 10, 1896. The first-named vessels was allotted to the Cramps, of Philadelphia, and has already undergone her trials with great success, achieving a speed of 17.01 knots an hour. The Illinois is approaching completion at the yard of the Newport News Shipbuilding Company, and the Wisconsin has recently completed her official trials, on which she made an average speed of 17.17 knots per hour. The principal dimensions of the vessel are as follows: Length, 368 feet; beam, 72 feet 2½ inches; mean draft, when the ship is fully equipped ready for sea, with all stores on board and a normal coal supply of 800 tons, 23.6 feet. The displacement of the vessel with two-thirds of ammunition and two-thirds of stores on board is 11,565 tons. Her bunkers have a maximum coal capacity of 1440 tons. She is propelled by twin engines. They are of 10,000 estimated indicated horse-power, although this was considerably exceeded on the trial trip, when the maximum indication reached 12,322. They are of the inverted three-crank, triple-expansion type, and while they conform broadly to the specifications drawn up by the Naval Bureau of Engineering, the builders have introduced specialties of design, which they have already used with marked success in other naval vessels built for the government. The most noticeable of these is the framing of the engines, which is formed of forged built-up columns at the back, and turned columns for the front side of the engine. The forged column is of a type which was first used by these builders in the engines of the Olympia, and later in those of the battleship Oregon. It is built up of forged plate sides, on which are flanges for securing the column to the bedplate and to the cylinder bottoms. Between the sides is bolted in the casting which forms the main guides, and below the guides the sides are spread, and a webplate is worked in, the lower half of the frame being thus in the form of an inverted Y. It is claimed by the builders that this type of frame provides unusual rigidity, and the forged iron is more reliable than the material of the usual cast steel frames. The high-pressure cylinder is 33½ inches in diameter, the intermediate 51 inches, and the low-pressure cylinder 78 inches in diameter, the common stroke being 4 feet. The crank shaft is made of three interchangeable and reversible sections; the crank pins are 14¾ inches in diameter by 17 inches long; and there is a

7½-inch hole axially through the shaft and crank pins. The thrust shafts are 14 inches in diameter, and the propeller shafts 14¾ inches in diameter, with a 9¾-inch axial hole throughout their entire length, except in the after section, where they pass through the hub of the propeller, in which portion the hole is tapered.

The engines are fitted with straight-push, reversing gear, and the air pumps are independent of the main engine. The main circulating pumps, which supply the condensers, may be used to empty the bilge of the ship, for which purpose they have a capacity of 12,000 gallons per minute. The screw propellers are three-bladed and are made of manganese bronze. They are 15½ feet in diameter and the pitch is 17 feet 6 inches. Steam is supplied by eight single-ended steel boilers in four compartments; the boilers are 15 feet 6½ inches in diameter and 10 feet in length.

The Wisconsin is a fine, seaworthy vessel with a good freeboard of about 20 feet forward and 13 feet aft. Her main battery of four 13-inch breech-loading rifles is carried in two barbette turrets; the barbettes are plated with 15 inches of Harveyized steel, and the turrets with 14 inches. She has a water-line belt from 7 to 8 feet in depth, which varies in thickness from 16½ to 9½ inches at top and bottom respectively amidships to 4 inches at the stem. This belt extends as far aft as the after barbette. With this armor is associated a steel deck 2¾ inches in thickness on the flat, 3 inches in thickness forward, and 4 inches from the after end of the armor belt to the stern. The main rapid-fire battery consists of fourteen 6-inch rapid-fire guns, ten of which are carried on the main deck and four on the spar deck. Of these on the main deck, eight are carried within a central citadel, which is protected with 6 inches of Harveyized armor, the armor extending in the wake of the guns and running across at the ends of the battery diagonally to a junction with the 12-inch armor of the barbettes. The two other guns on the main deck are carried well forward in sponsons armed with 6 inches of Harveyized steel. The four guns on the spar deck are carried immediately above the central rapid-fire battery and are likewise protected with 6 inches of armor. The secondary battery is made up of sixteen 6-pounders, six 1-pounders, four Colts and two 3-inch field guns. There are also four Whitehead torpedo dischargers. The total complement of officers and men will be 493. Considering that the keel of the vessel was not laid until February, 1897, it is evident that improved facilities are enabling our shipbuilders to turn out these big vessels more rapidly than they could when earlier vessels of the Oregon type were built.—*Scientific American*, Dec. 8, 1900.

U. S. TORPEDO-BOAT DESTROYER DALE.

In *Marine Engineering* for August brief mention was made of the launch of the torpedo-boat destroyer Dale on July 24 at the yards of the Wm. R. Trigg Co., Richmond, Va. The following particulars will be of further interest.

The Dale is the first of the sixteen destroyers now building for the Government to be launched. As it was a side launch, unusual interest was created and upwards of 5000 people witnessed the scene.

Miss Mary H. Wilson, of Philadelphia, a descendant of Commodore Dale, after whom the boat is named, acted as sponsor and succeeded very well in breaking the bottle of "yellow label" over the bow of the

destroyer as it took its initial plunge. The boat glided smoothly off the ways without a hitch of any kind and came to a standstill after having gone not more than 30 feet, resting gracefully on the water, with every line showing the fineness that will permit the high speed it is designed to make. The dimensions and particulars of the launching ways were as follows:

Groundways, 12 inches by 12 inches, yellow pine.
Groundway shoes, 12 inches by 1½ inches, oak.
Slidingways, 5½ inches by 12 inches.
Length of slidingways, 23 feet.
Inclination of ways, 2 inches to 7 feet.
Number of ways, 10.
Bearing surface, 230 square feet.
Number of triggers, 5.
Launching weights, 193 tons.
Pressure per square foot, .839 ton.

A preparation of No. 1 Albany grease and beef tallow was applied about one-half inch thick on the ways and then covered with soft soap. Owing to the heat, considerable more tallow was used than is usually required.

The dimensions of the Dale are as follows:

Length over all	245 ft.
Beam	23 ft.
Depth	14 ft. 3 in.
Draft	6 ft. 6 in.
Normal displacement	420 tons.
I. H. P.	8,000
Speed	28 knots.
Thornycroft boilers, Daring type	4
Total grate surface	315 sq. ft.
Total heating surface	17,768 sq. ft.
Steam pressure, boiler	300 lbs. per sq. in.

Two four-cylinder triple-expansion engines. Diam. of cylinders, 20¼ in., 32 in., and two 38 in., each with a common stroke of 22 in.

TORPEDO-BOAT BARNEY.

At the yard of the Bath Iron Works, Bath, Me., on July 30, was launched the U. S. torpedo-boat Barney. This boat is one of the number authorized by Congress in 1898. Her dimensions and chief particulars are as follows: Length, 157 feet; beam, 17 feet; depth amidships, 10 feet 9 inches; mean draft, 4 feet 8 inches; displacement, 160 tons; speed, 28 knots; cost $170,000. The armament will consist of three pairs of R. F. guns and three tubes for short 18-inch Whitehead torpedoes.—*Marine Engineering*, Sept., 1900.

BOOK REVIEW.

The Frigate Constitution.

In giving to the public this interesting, well-written and reliable history of the most famous ship of our navy, Prof. Hollis has done a good work, and is to be congratulated. Though the book is not a naval history, the reader will get a very good idea of the events connected with the establishment of the navy and its administration during the first half of the 19th century.

The numerous illustrations add much to the value of the book.

Navy officers will be glad to find that, even in a book intended for popular reading, the author has seen fit to use technical and nautical terms in describing sea-fights, rather than the mongrel vocabulary that mars some of the so-called popular histories of the navy. J. P. P.

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NOVEMBER 10. Trial of the Barney. Trial of the Stockton. A Naval General Staff. The Military Schools.

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NOVEMBER 24. Report of the Assistant Secretary of the Navy. Annual Report of Chief of Bureau of Equipment. Fortification Board Report.

DECEMBER 1. Report of the Secretary of the Navy. The New Army Bill. The Pacific Cable. The Naval Recommendations.

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DECEMBER 15. New Protected Cruisers.

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NOVEMBER. A Russian Petroleum Pipe Line. Smoke Abatement. Electricity in the Printing Office. Charges for Electric Energy. Continental Steam Engine Practice.

DECEMBER. Electricity at the Paris Exhibition. Machine Tools at the Paris Exhibition. The Steam Automobile. Motive Power and Industry. The Development of the Gas Engine.

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NOVEMBER, 1900. Improvements in Bridge Construction. The Chemistry and Physics of Cast Iron.

DECEMBER. The Use of Blast-furnace Gases in Gas Engines. Expanded Metal and Some of the Uses it is Put.

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NOVEMBER, 1900. Fighting in the Philippines. The National Guard. Notes on Vaccination. Comments and Criticism.

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OCTOBER. Submarine Boats: A Comprehensive History. Dutch Torpedo-boat Hydra. Results of H. M. S. Belleisle Gunnery Experiments. Superimposed Turrets on U. S. Battleships. Forty Years of Vessel Construction.

NOVEMBER. U. S. Battleship Wisconsin. Japanese Shipyard in Nagasaki Harbor.

DECEMBER. Government Report of Shipbuilding Conditions of the United States. Record of Home and Foreign Launches.

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SEPTEMBER 1, 1900. Air Resistance to Moving Bodies. Battleship Kentucky. Water-tube Boilers. Salvage of the Oregon. Awards at Paris Exposition. Safety in Smokeless Powder. Wood Preserving.

SEPTEMBER 22. Coal Exports of America. Home of the Krupp Gun. New Era of American Sailing Vessels.

OCTOBER 13. High-power Engines. Naval Progress. Signaling with Kites. Launch of the Wyoming.

OCTOBER 15. Air Resistance to Moving Bodies. Armament of Battleships and Cruisers. Krupp Iron Works. Mooring Device. Ordnance of Pan-American Exposition. Abandonment of Port Royal Naval Station.

OCTOBER 20. 16-inch Rifle. Torpedo-boat Bailey. Water-tube Boilers. Wireless Telegraphy.

OCTOBER 27. Armor-plate Makers. Galvanic Action of Copper Sheathing. Theory of Electricity. Report on Naval Maneuvers. Wood Sheathing. Interesting Experiments with Torpedoes.

NOVEMBER 3. French Cruisers.

NOVEMBER 10. New Type Battery. Centrifugal Gun. Present and Future Steamships. Wireless Telegraphy.

NOVEMBER 17. New Battleships. Long-range Firing. New Propeller. Trial Trip of the Variag.

NOVEMBER 24. Armor Controversy. New Barometer. Long-range Rifle Fire. Steam Turbine. Swiss Turbine. The Viper.

DECEMBER 1. The Cruiser California. Efficiency of Guns. Pacific Coast Shipbuilding.

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SEPTEMBER. Vertical Section through Superimposed Fore Turrets of U. S. Battleship Kearsarge from Keel to Roof of Upper Gun Emplacement. The Training of Seamen. The Range Question. An Italian View of the Boer War.

OCTOBER. The Knights Hospitallers and Ambulance Work in War. From Enslin to Bloemfontein with the 6th Division. Russian Progress in East Asia. The Navy under Cromwell: Its Strength and Cost, 1654. New Naval Tactical Game.

NOVEMBER. Sketch of Country round Ladysmith, showing Boer Positions. The Ladysmith Pigeon Post. On the Relation of Public Secondary Schools to the Organization of National Defense. Speed in Naval Tactics. The Bombardment of Paris in 1870-71, and the Reasons which Delayed it.

DECEMBER. The New Japanese First-class Battleship Mikasa. The Routes of Submarine Cables. The Great Trans-Siberian-Manchurian Railway. The Question of the Type of Battleships and Cruisers Most Suited for the Russian Fleet.

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NOVEMBER. History of Ballistics. What Class of Men-of-war would be most Desirable for England's Navy judging from Experiences gained in the China-Japan and in the Spanish-American Wars.

DECEMBER. Ancient Egyptian Types of Ships and their Evolution. Launching of the German Cruiser Amazone.

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OCTOBER, 1900. Medical Attendance on Board Ship during the 17th and 18th Centuries. Test of the Sponge Respirator for People in Bunkers and Fire-rooms. Loss of the French Torpedo-boat Destroyer Framee. Participation of H. M. S. Iltis and the German Landing Troops during the Engagement of the Taku Forts. The War in China. The Breakage and Repair of a Thrust Bearing on Board the Steamer Sonneberg.

NOVEMBER. The participation of the German Navy in the Seymour Relief Expedition and the Engagements in and around Tien-tsin during June and July, 1900. Formulas for determining the Military Values of Men-of-war. Naval Alliances in War.

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OCTOBER 6, 1900. The Spanish Navy. Programme of the International Regatta at Cannes, to be held in February and March, 1901.

OCTOBER 13. Are Sails Necessary to become Sailors?

OCTOBER 20. Fishing Vessels at the Paris Exposition.

OCTOBER 27. The German Navy and the German Emperor. The Merchant Marine at the Paris Exposition. List of French Men-of-war and their Stations on October 25, 1900.

NOVEMBER 3. The Austrian Armored Coast-defense Vessel Habsburg. International Maritime Congress.

NOVEMBER 10. The Use of Torpedoes on Board Fighting Ships.

NOVEMBER 17. Apropos of Submarine Telegraphy. The Russian Cruiser Askold.

NOVEMBER 24. Report of M. Fleury-Ravarin on the Naval Budget.

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NOVEMBER. Supplement. Tactical Considerations of the War in South Africa. The Attack of Fortifications in a Campaign. Graphic Comparison of the Ballistic Qualities of Large-caliber Guns. Development of German Naval Construction. The Question of Guns in the Anglo-Boer War. Notes on the Transportation of Horses, from Experiences furnished by the South African War. Sanitary Service in a cavalry Division in time of War.

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No. 4, APRIL, 1900. Auxiliary Cruisers in the Spanish-American War. Comparison of Existing Armies and Fleets of the Present Day. Principles of the Organization of Naval Forces. The Personnel of the Danish Navy. Change in the Personnel of the United States Navy. Life-saving Establishments on the Coasts of Europe. Observation of Stars at Sea. Spencer Miller's Method of Coaling at Sea. Fundamental Principles of Selection and Distribution of Guns for Ship's Armament. Metallurgical Notes.

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Miscellaneous: Export of Stone Coal from Japan.

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NOVEMBER. Ranging with Field and Mountain Guns. The Battle of Diamond Hill as it appeared from the 82d Field Battery, June 11 and 12, 1900. The Figure of Merit of any Company Practicing Seawards. The Boer War, 1899-1900. The Rocket Troop. The 2d Brigade Division, Royal Field Artillery, in the Natal Campaign, 1899-1900. The Training of Battery Horses. The Artillery Escort.

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SEPTEMBER, 1900. Marine Boiler Explosions. The Boilers of the Navy. Waste of Fuel from Boiler Scale. Launch of an Indian Troopship at Govan.

OCTOBER. Marine Boiler Explosions. Shipbuilding in America. Petroleum Fuel for Warships. Liquid Fuel on Steamers. The Fastest Big Warship. Japanese Steamships for Europe. Boiler Horse-power. Present-day Wood Shipbuilding in America.

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SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1901.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1902. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

7. The successful competitor will be made a Life Member of the Institute. If the essayist second in order of merit receive "Honorable Mention," he will also be made a life member.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of the Board of Control.

E. W. EBERLE,
Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *June 1, 1900.*

Longitud del Meridiano de Manila.

1° 30′ 0° 30′ 1° 30′ 2°

19° 30′ 18° 30′ 17° 30′ 16°

ISLAS BABUYANES

I.s BALUPIRI

I.s FUGA

I.s CAMIGUIN

C.e ENGAÑO

I.s Palaui

C.e BOJEADOR

Seno de Bangui

Barra de Cagayan

GOLFO DE LINGAYEN

BOLINAO

Pto Bolinao

Pto Masinloc

Pto Sta Enn.da de Dinglan

Enn.da de Paranan

Enn.da de Dilasac

Enn.da de Baler

C.te S.t ILDEFONSO

ISLA DE

LUZON

Var.n O

30' 3° 30' 4° 30' 5° 30'

19°

30'

18°

30'

17°

30'

16°

30'

15°

MILITARY CABLES

MANILA-CAVITE

TAGUIG-CALAMBA

TAGUIG-BINANG

CALAMBA-LOS BAÑOS

LOS BAÑOS-SANTA CRUZ

CEBU-ORMOC

NAIC-CORREGIDOR

GUINAYANGAN-PASAGAO

© Arr.ºClaro é Anson.

PROGRESS MAP

— OF —

Signal Corps Telegraph Lines & Cables

IN THE

Var.n 0°

MILITARY DIVISION OF THE PHILIPPINES

BASED ON MAP OF MONTERO Y GAY, ISSUED BY THE MILITARY INFORMATION BUREAU, ADJUTANT GENERAL'S OFFICE.

REPRODUCED UNDER THE DIRECTION OF

BRIGADIER GENERAL A. W. GREELY

CHIEF SIGNAL OFFICER, U. S. ARMY.

CORRECTED TO JULY 1ST, 1900.

MILITARY TELEGRAPH LINES

MILITARY CABLES

PROJECTED CABLES

PROJECTED MILITARY TELEGRAPH

CABLES, CONTEMPLATED

16°
15°
30'
14°
13°
12°
C.ᵒ S.ⁿ ILDEFONSO
Eus.ᵈᵃ de Baler
P.ᵗᵃ Sua
Ens.ᵈᵃ de Dingalan
ISLA DE
POLILLO
I.ˢ Palasanongan
I.ᵃ Jomalig
ISLAS CALAGUAS
I.ˢ Tinaga
I.ᵃ Guintinua
P.ᵗᵃ Masinloc
P.ᵗᵃ Capones
P.ᵗᵃ de Subig
Fondeadero de
Binangonan
MANILA
Cable Manila to Hong Kong
MANILA
LAG.ᵒ DE
TAAL
I.ᵃ Alabat
BAHIA
DE
S.ⁿ MIGUEL
Ens.ᵃ de
Caima
I.ᵃ DE LUBANG
I.ˢ Ambil
I.ˢ Golo
C.ᵒ Santiago
Seno de
Balayan
Ens.ᵃ de
Batangas
Marieaban
P.ᵗᵃ Malabrigo
Seno de
Tayabas
Banalacan
ISLA
MARINDUQUE
SENO DE
RAGAY
ISLA DE BURIAS
I.ᵃ Verde
C.ᵒ Calavite
ISLA DE
MINDORO
PASO DEL O. DE APO
PASO DEL E. DE APO
P.ᵗᵃ Dumali
P.ᵗᵃ Maestre de
Campo
I.ˢ Bauton
I.ˢ Simara
P.ᵗᵃ Dayagan
I.ˢ Romblon
I.ᵃ DE SIBUYAN
ISLA DE
TABLAS
Eastern Company's Line
P.ᵗᵃ Caballan
I.ᵃ Carabao
Var.ⁿ 1° NE.
P.ᵗᵃ Bugui
Bahia Ma
I.ᵃ Semevara
I.ᵃ Sibay
P.ᵗᵃ Nasog
P.ᵗᵃ Palanduta
I.ᵃ Jintotolo
Los Zapatos
I.ᵃ BUSUANGA
Busuanga
Peñon de Coron
CALAMIAN
ó CULION
I.ᵃ Linapacan
Grupo Quiniluban
P.ᵗᵃ Lipata

REPRODUCED UNDER THE DIRECTION OF

BRIGADIER GENERAL A. W. GREELY

CHIEF SIGNAL OFFICER, U. S. ARMY.

CORRECTED TO JULY 1ST, 1900.

MILITARY TELEGRAPH LINES

MILITARY CABLES

PROJECTED CABLES

PROJECTED MILITARY TELEGRAPH

CABLES, CONTEMPLATED

BRITISH CABLES

DEPARTMENT BOUNDARIES

Banco con 6 met.s de agua

TIERRAS DE CAMARUAN

SENO DE LAGONOY

SENO DE ALBAY

ISLA DE LUZON

ISLA DE CATANDUANES

Canal de Maqueda

ESTR.o DE S.t BERNARDINO

ISLA DE MASBATE

SENO DE ASID

ISLA DE SAMAR

Var.a 0°.3o'. NE.

Var.a 1°. NE.

16°

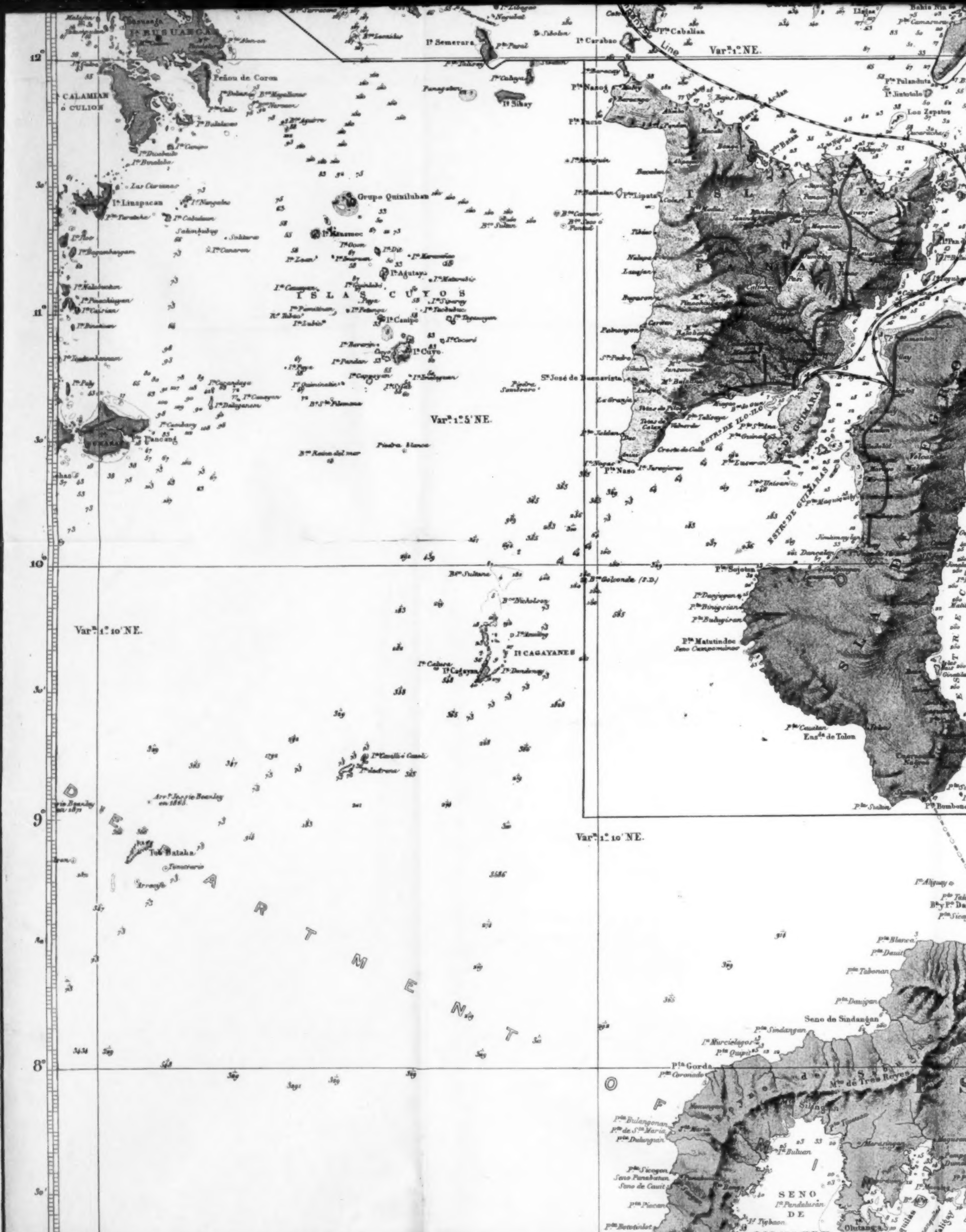
15°

14°

13°

12°

3o'



12°
30'
11°
30'
10°
30'
9°
8°
30'
I.a BUSUANGA
CALAMIAN
ó CULION
Peñon de Coron
I.a Linapacan
Grupo Quiniluban
I.a Manamoc
I.a Agutaya
ISLAS CUYOS
I.a Canipo
I.a Cuyo
Pancang
I.a Semerara
I.a Carabao
P.ta Caballan
I.a Sibay
P.ta Nasog
P.ta Palanduta
I.a Jintotolo
Los Zapatos
Var.n 1.° NE.
Var.n 1.° 5' NE.
Var.n 1.° 10' NE.
ISLA DE PANAY
St. José de Buenavista
P.ta Naso
ESTR.o DE ILO-ILO
GUIMARAS
ESTR.o DE GUIMARAS
P.ta Sojoton
P.ta Matutindoc
Ens.da de Tolon
I.s CAGAYANES
I.a Cagayan
Tub Bataha
DEPARTAMENTO DE
Seno de Sindangan
P.ta Gorda
M.te de Tres Reyes
SENO DE SIBUGUEY
Seno de Sibuco
Olutanga

SENO DE
ASID
MAR DE SULU
ISLA DE
MINDANAO
ISLA DE
LEYTE
ISLA DE
BOHOL
SURIGAO
ISLA DE SIQUIJOR
ISLA CAMIGUIN
BAHIA
BUTUAN
BAHIA
MACAJALAR
BAHIA ILIGAN
BAHIA
DE
ILIGAN
Var.ª 1.º NE.
Var.ª 1.º 5 NE.
1.º DINAGAT
1.º SIARGAO
Bahia
S.ta Pedro
S.ta Pablo
Banco de Dasajon
Canal de Surigao
Canal de Bohol
Canal de Panglao
Canal de Camiguin
Canal de Dinagat
Estrecho de Surigao
Estrecho de Bohol
Estrecho de Mindanao
Laguna de Lanao ó de Mahomedanos
Lago Malubog
Lago Sugut
12°
11°
10°
9°
8°
30'

Seno de Sindangan

Pta Gorda

Pta Bulangonan

Pta de Sta María

Pta Dalanguin

Pta Sicoggon

Seno Panabutan

Seno de Cauit

Pta Pucan

Pta Bonotinlot

Seno de Sibuco

Pta Pedrusan

Pta Batalimpon

S. Ramon

Ayala

Pta Caldera

SENO DE SIBUGUEY

Pta Lalangan

Seno Dumanquilas

Seno Maligay

Pta Sacol

EST.o DE BASILAN

ISLA DE BASILAN

GRUPO BASILAN

Var.n 1.° 20' NE.

Pangutarang

Paso Pangutarang

Pta Lapacan

Pta Cap

Pta Tagalan

GRUPO JOLÓ

GRUPO DE SAMALES

GRUPO SIASI

GRUPO KEENAPOUSSAN

GRUPO TAUI TAUI

ARCHIPIÉLAGO DE JOLÓ

MAR DE CÉLE

Longitud Oriental del Meridiano de S.Fernando.

8°

7°

6°

5°

4°

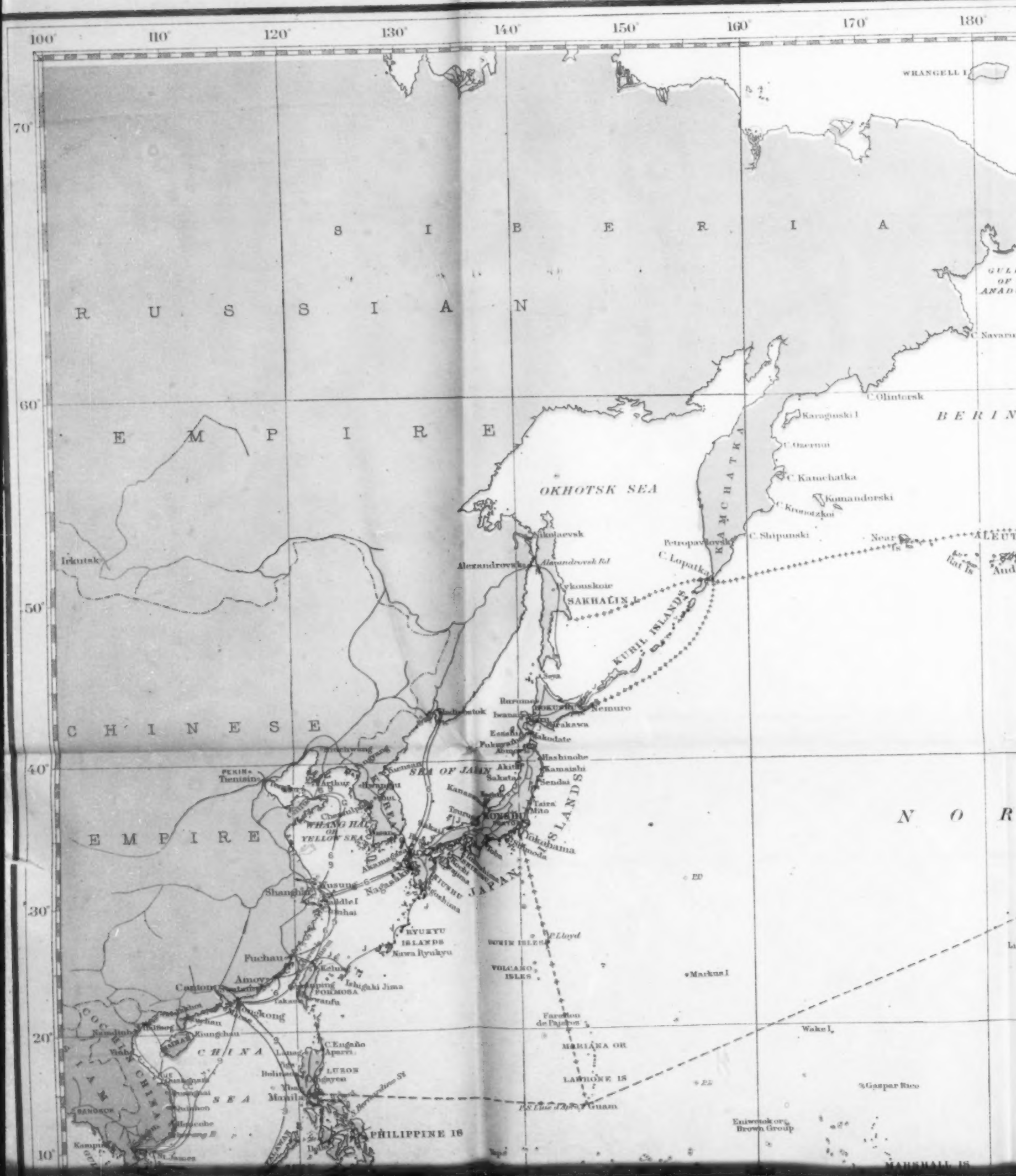
126°

127°

128°

129°

S D A D E M I N D A N A O
Laguna de Lanao ó de Magundanao
Rocas S.D.
Seno Malubug
Pta Sambulauan
BAHIA DE ILLANA
Pta Tugapangan
Ia Bongo
Polloc
Pta Panalisah
Pta Tapian
Tombac
Pta Quidapil
Mte Tiruray
Enda de Linao
Pta Lebak
Pta Donauan
Enda de Tuna
Pta Malatuna
Pta Pola
Pta Bucul
Bantangan
Laguna de Liguasan
Lagª de Buluan
Mte Dinalungan
Bª de Sarangani
Pta Bulakan
Pta Tucapanga
Pta Silacay
Pta Guay
Olaniaan
Ia Balut
Ia Sarangani
Ia Sarangani del E.
Dávao
ISLA DE SAMAL
Ia Talicut
SENO DE DÁVAO
Pta Colapsin
Pta de Jubalan
Seno de Sacaron
Pta Malita
Lais
Pta Calian
Pta Panain
Pta Buguis
Pta Banos
Seno de Mayo
Pta Lamigan
Bahia de Pujaga
Pta Macaonan
Pta Salarala
Pta Luban
Pta Baclac
Cº Sº Agustin
Mte Magdiuta
Bislig
Pta Tambog
Pta Pagliangan
Ia Cabugao
Pta Bogoso
Ia Quinablangan
Pto Baganga
Pta Baculin
Pta Sancol
Enda de Caraga
Pta Subay
Pta Caroman
Pta Mandanga
Ia Palmas
Ia Mata
Ia Ariaga ó de la Silla
Ia Hay cock ó Mearac
Ia Anda
Ia Armadores
Ia Saravia ó Hay cock
Banco Hay cock
Rocas Ifigenia
Ia Salibabo
Is TU
E B E S
8°
7°
6°
5°
4°
30'
130°
131°
132°
133°


100°
110°
120°
130°
140°
150°
160°
170°
180°
70°
60°
50°
40°
30°
20°
10°
RUSSIAN EMPIRE
SIBERIA
CHINESE EMPIRE
CHINA
JAPAN
NORTH PACIFIC OCEAN
WRANGELL I.
GULF OF ANADYR
C. Navarin
C. Olintorsk
Karaginski I.
BERING
C. Olutorsk
C. Kamchatka
Komandorski
C. Kronotzkoi
C. Shipunski
Petropavlovsk
C. Lopatka
KAMCHATKA
OKHOTSK SEA
Nikolaevsk
Alexandrovsk
Alexandrovsk Rd
Irkutsk
Yakouskoie
SAKHALIN
KURIL ISLANDS
Saya
Nemuro
Hakodate
Hashinohe
Kamaishi
Sendai
Taira
Mito
Yokohama
HONSHU
SEA OF JAPAN
Akita
Sakata
Kanasaki
Tsuruga
Fushiki
Nagasaki
Shanghai
Yusung
Middle I.
Pinhai
Fuchau
Amoy
Canton
Swatow
Kelung
Tamsui
Ishigaki Jima
FORMOSA
Takao
Wanfu
Kiungchau
Namtuhai
Kiung-hau
Hoihau
C. Engaño
Aparri
LUZON
Bolinao
Manila
Subig
Mariveles
Batangas
Tayabas
Sorsogon
Masbate
Kampit
St. James
PHILIPPINE IS
SANGOOS
YELLOW SEA
WHANG HAI OR
PEKIN
Tientsin
Chefoo
Port Arthur
Newchwang
Chemulpo
Gensan
KOREA
Nagasaki
Goshima
RYUKYU ISLANDS
Nawa Ryukyu
BONIN ISLES
VOLCANO ISLES
P. Lloyd
Farallon de Pajaros
Markus I.
Wake I.
MARIANA OR LADRONE IS
Guam
Gaspar Rico
Eniwetok or Brown Group
MARSHALL IS
Ratak Is
Andreanof
ALEUTIAN

THE SUBMARINE CA

WITH THE PRI

SUBMARINE CABLE CONNECTIONS

WITH THE PRINCIPAL OVERLAND TELEGRAPH

S OF THE WORLD
APH LINES

OF THE WORLD

H LINES

50° 60° 70° 80° 90° 100° 110°

70° 60° 50° 40° 30° 20° 10°

Yenisei R.

Mezen

Arkhangel

RUSSIAN EMPIRE

Tobolsk

Tomsk

Irkutsk

Guriev

Astrakhan

Koul Koudouk

Kasalinsk

CASPIAN SEA

Krasnovodsk

Recht

Hurfrouch

TEHERAN

PERSIA

AFGHANISTAN

KABUL

CHINESE EMPIRE

Bushire

Maskat

NEPAL

BHOTAN

BRITISH INDIA

Calcutta

Chittagong

Bhaunagara

Bombay

Chicacole

Vizagapatam

Cocanada

Masulipatam

Nellore

Madras

Pondicherri

Negapatam

Jafnapatam

Trincomali

Tenasserim

Basseine

Diamond I.

Elephant P.

Amherst

Moulmein

Sittyoodin

BANGKOK

ANDAMAN IS.

BAY OF BENGAL

ARABIAN SEA

LAKADIVE IS.

Mangalore

Kumpta

Vengurla

Goa

Vingorla

Quilon

Cochin

Tellicherry

BRITISH SOMALI

Lohaiya

Hodeida

Zubeir

Aden

Karachi

Sundiyam

Chabbar

Gwadar

Jask

Cheduba I.

Sangor I.

False Pt.

Akyab

Ramree

Cheduba

Cape Negrais

Tavoy

Mergui

Junk Ceylon

Penang

Malacca

Singapore

Rhio

Banca

Borneo

Sumatra

Java

Timor

Celebes

Amboyna

Ternate

Gilolo

Manilla

Luzon

Mindoro

Panay

Cebu

Mindanao

Sooloo

Palawan

Hainan

Tonquin

Cochin China

Cambodia

Siam

Saigon

Kamboi

Cape Cambodia

Kampot

Pulo Condore

Kiungchau

Hainan

Tsiungchau

Hoihau

Namtimo

Vinh

Kiangnan

Quangsai

Quangtung

Yunkon

Tsiungchau

Kampot

St. James

St. Jaques

Tonquin G.

Siam G.

Gulf of Siam

Gulf of Martaban

Andaman Sea

Straits of Malacca

Straits of Sunda

Straits of Banca

Straits of Gaspar

Straits of Macassar

Straits of Bali

Straits of Lombock

Straits of Timor

Straits of Manilla

Straits of Formosa

Formosa

Loo Choo Is.

Japan

Yellow Sea

Gulf of Pechelee

Gulf of Corea

Corea

Gulf of Tartary

Sea of Japan

Sea of Okhotsk

Kamtschatka

Behring's Straits

Behring's I.

Copper I.

Kurile Is.

Aleutian Is.

Alaska

Sea of Kamtschatka

Gulf of Anadir

Anadir R.

Kolyma R.

Yana R.

Lena R.

Indigirka R.

Jana R.

New Siberian Is.

Liakhov I.

Sea of Liakhov

Gulf of Bostreskoi

Boreskoi I.

Taimura R.

Taimura Peninsula

Cape Taimura

Cape Chelyuskin

Gulf of Obi

Obi R.

Obdorsk

Beresov

Berezov

Tobolsk

Tomsk

Irkutsk

Yeniseisk

Krasnoyarsk

Yenisei R.

Lake Baikal

Lake Aral

Lake Balkash

Lake Tengis

Lake Ala Kul

Lake Issikul

Lake Zaisan

Lake Dzaisang

Lake Koko Nor

Lake Lop Nor

Lake Tchaka

Lake Tsing Hai

Lake Tali

Lake Yung Ning

Lake Tung Ting

Lake Poyang

Lake Tai

Lake Hung Tse

Lake Chaou

Lake Ta Hu

Lake Kiang Ling

Lake Tsing Tse

Lake Tsing Kiang

Lake Tsing Ho

Lake Tsing Pi

Lake Tsing Ling

Lake Tsing Yang

Lake Tsing Tung

Lake Tsing Shan

Lake Tsing Yuan

Lake Tsing Ho

Lake Tsing Pi

Lake Tsing Ling

Lake Tsing Yang

Lake Tsing Tung

Lake Tsing Shan

Lake Tsing Yuan

40°
30°
20°
10°
0°
10°
20°
30°
40°
50°
PEKIN
Tientsin
EMPIRE
SEA OF JAPAN
WHANG HAI OR YELLOW SEA
Arthur
Chemulpo
Hashinohe
Akita
Kamaishi
Sakata
Sendai
Taira
Mito
HONSHIU
TOKYO
Yokohama
Shimoda
ISLANDS
JAPAN
KIUSHU
Nagasaki
Kagoshima
Shanghai
Wusung
Middle I
Chinhai
RYUKYU ISLANDS
Nawa Ryukyu
Fuchau
Amoy
Canton
Kelung
FORMOSA
Ishigaki Jima
Hongkong
Kiungchau
COCHIN CHINA
SIAM
BANGKOK
CHINA SEA
C.Engaño
Aparri
LUZON
Manila
S. Bernardino St
PHILIPPINE IS
Quangngai
Quinhon
Honcohe
St James
St Jaques
GULF OF SIAM
MINDANAO
G of Davao
SULU SEA
Kudat
Labuan
Brunei
CELEBES SEA
Sadong
Sarawak
BORNEO
Pontianak
GILLOLO
CERAM
Amboina
JAVA SEA
Telok Betung
SUNDA STR
JAVA
Banjuwangi
FLORES
TIMOR
Kupang
Timor Laut
Dobbo
Arruls
ARAFURA SEA
P.Darwin
Palmerston
GULF OF CARPENTARIA
Derby
Broome
BONIN ISLES
P.Lloyd
VOLCANO ISLES
Markus I
Farallon de Pajaros
MARIANA OR LADRONE IS
Guam
Wake I
Gaspar Rico
Eniwetok or Brown Group
Yap
PELEW IS
CAROLINE ISLANDS
Jamestown Hr
Ponapi
Ualan I
MARSHALL IS
Jaluit
BONHAM IS
GILBERT IS
Nonuti I
Admiralty Is
NEW MECKLENBURG
NEW POMERANIA
Blanche B
Meoko Hbr
BOUGAINVILLE
SOLOMON IS
Treasury I
ELLICE IS
Funafuti
PAPUA OR NEW GUINEA
Gulf of Papua
Thursday I
C York
TORRES STRAIT
Moreton
C Melville
Cooktown
CORAL SEA
STA.CRUZ IS
Espirito Santo
NEW HEBRIDES
FIJI IS
Cairns
Cardwell
Townsville
Burketown
Bowen
Bloomsbury
Mackay
St Lawrence
NEW CALEDONIA
LOYALTY IS
Noumea
N.W.Cape
Sharks B
P Gregory
Geraldton
Dongarra
AUSTRALIA
Alice Springs
Mattaburra
Rockhampton
Gladstone
Sandy C
Maryborough
Charleville
Gympie
Brisbane
Heads
NORFOLK I
Grafton
Kempsey
P.Macquarie
KERMADEC IS
Perth
Fremantle
Peel Inlet
Bunbury
Busselton
Eucla
Israelite B
Esperance B
Bremer B
Albany
King George Sd
Pt. D'Entrecasteaux
Streaky B
Elliston
Pt. Lincoln
C. Borda
Adelaide
Wakefield
Augusta
Newcastle
Sydney
Kiama
Moruya
Eden
Gabo I
Melbourne
Portland
Robe
Mc Donnell
Warrnambool
C. Otway
Sale
P. Albert
Wilson
Macquarie Hbr
TASMANIA
Oyster B
Hobart
NEW ZEALAND
Mongonui R
P. Russell
Whangerei
Hokianga
Auckland
Warkworth
Tokota
Grahamstown
Maketu Cove
Gisborne
NORTH I
P.Napier
Wanganui
New Plymouth
Wellington
Collingwood
Nelson
Westport
Charleston
Greymouth
Hokitika
Blenheim
Kaikoura
Leithfield
Christchurch
Akaroa Hbr
Ashburton
Timaru
Oamaru
Palmerston
Dunedin
Balclutha
Bluff Hbr
Invercargill
Riverton
SOUTH I

R T H P A C I F I C

O C E A N

MIDWAY IS
Lisianski I.
Laysan I.
Gardner I.
Necker I.
Honolulu
HAWAIIAN IS
Hilo B.
Johnston I.
Palmyra I.
Washington I.
Fanning I.
Christmas I.
Howland I.
Nantucket
PHOENIX IS
Enderbury I.
UNION IS
Nukumanu
SAMOAN IS
Apia
Pago Pago
FRIENDLY IS
Tongatabu
HERVEY OR COOK IS
Rarotonga
Tubuai or Austral Is
TUAMOTU OR LOW ARCH'GO
Taiu Hiva
MARQUESAS IS
SOCIETY IS
Tahiti
Takarawa
Easter I.
Raoul I
CHATHAM IS

Salt Lake City
Denver
S. Francisco
Oakland
San Jose
Monterey
S. Luis Obispo
Santa Barbara
San Pedro
S. Diego
Yuma
LOWER CALIFORNIA
GULF OF CALIFORNIA
Guaymas
Pichilingue
La Paz
Mazatlan
San Blas
Manzanillo
MEXICO
Tampico
Galveston
Indianola
Rockport
Brownsville
Matamoras
New Or
Tuxpan
Acapulco
Salina Cruz

GALAPAGOS I

S O U T H P A C I F I C

O C E A N

EXPLANATION.

The submarine cable connections that are marked with letters represent the telegraph cables that are and operated by sovereign states. Those that are marked with numbers represent telegraph cables t owned and operated by private companies. The explanation of the names of the countries that the represent and of the names of the companies that the numbers stand for is subjoined.

GOVERNMENTS.	PRIVATE COMPANIES.	
A. Austria.	1. Direct Spanish Telegraph Company.	15. Brazilian Submarine Telegraph Company.
B. Belgium.	2. Halifax and Bermuda Cable Company.	16. African Direct Telegraph Company.
B. Great Britain	3. Spanish National Submarine Telegraph Company.	17. Cuba Submarine Telegraph Company.

ANATION.

with letters represent the telegraph cables that are owned
narked with numbers represent telegraph cables that are
xplanation of the names of the countries that the letters
numbers stand for is subjoined.

PRIVATE COMPANIES.

ompany.

15. Brazilian Submarine Telegraph Company.
16. African Direct Telegraph Company.
17. Cuba Submarine Telegraph Company.
18. West India and Panama Telegraph Company.
19. Deutsche See-Telegraphen-Gesellschaft

AZORES OR WESTERN IS
Fayal
Graciosa
Terceira
San Jorge
S. Miguel
PORTUGAL
LISBON
MADRID
SPAIN
Palma
SARDINIA
Cagliari
Messina
Catania
Modica
Zante
Smyrna
Malta
Canea
Candia
Sitia
Latakia
Beirut
Damascus
Jerusalem
Yafa
Said
El Arish
Suez
CAIRO
Alexandria
Oran
Algiers
Tunis
Bizerta
Sousa
Sfax
Djerba
Gabes
Misrath
TRIPOLI
(Turkish)
TRIPOLI
(French)
ALGERIA
(French)
MEDITERRANEAN SEA
Gibraltar
Tangier
FEZ
Melilla
Alhucemas
Morocco
MOROCCO
Madeira
Funchal
CANARY IS
Tenerife
Palma
Gran Canaria
Palmas
Lanzarote
Arrecife
FEZZAN
EGYPT
LIBYAN
DESERT
NUBIA
TIRIS
(Spanish)
SAHARA
EL FALAT
(THE GREAT DESERT)
TERR. OF FEZZAN
WADAY
DARFUR
Sawakin
ERITREA
ABYSSINIA
ITALIAN
St Vincent
C. VERDE IS
St Iago
Praya
St Louis
SENEGAL
(French)
C. Verde
Dakar
Bathurst
GAMBIA
Bissao
PORTUGUESE GUINEA
FRENCH SOUDAN
Los Is.
Freetown
SIERRA LEONE
(Br.)
LIBERIA
Monrovia (Indep.)
ASHANTI
(Br.)
TOGO
DAHOMEY
NIGER TERRITORIES
(British)
Lagos
Forcados R.
Benin
Calabar
Cameroons
KAMERUN
(German)
Princes I.
(Port.)
Gaboon R.
Libreville
Corisco B.
St Thomas
(Port.)
C. Lopez
BRITISH EAST AFRICA
KONGO FREE STATE
(Belgian Protectorate)
GERMAN EAST AFRICA
Kabinda (Port.)
Kongo R.
Bagamoyo
Dar-es-Salaam
Mikindani
Loanda
Benguela
Mossamedes
C. Frio
ANGOLA
PORTUGUESE WEST AFRICA
BRITISH CENTRAL AFRICA
EAST AFRICA
MOZAMBIQUE
MAYARIKE
LAND
GERMAN SOUTH-WEST AFRICA
DAMARA LAND
NAMAQUA LAND
KALAHARI DESERT
BRITISH BECHUANA LAND
S. AFRICAN REPUBLIC
(TRANSVAAL)
ORANGE FREE STATE
NATAL
CAPE COLONY
Walfisch B.
P. Nolloth
Port Elizabeth
Durban (Natal)
Delagoa Bay
Cape Town
C. of Good Hope
E. London
Alfred
Elizabeth
Emmausdorp
Mossel Bay
Tristan da Cunha
Marion I.
St Paul
Fo Noronha
Natal
Pernambuco
Ascension I
St Helena
Maceio
Aracaju
Timbo
Valença
Catalina
Camamu
Rheos
Belmonte
P. Seguro
Caravellas
S. Mateos
Victoria
Trinidade
Rio de Janeiro
S. Joam da Barra
Parati
Santos
Cabo Frio
Cabo Corrientes
Cabo do Arroio
Rio Grande do Sul
SOUTH GEORGIA
ATLANTIC OCEAN
SOUTH OCEAN

A N T I C

C E A N

MADRID

SPAIN

PORTUGAL

LISBON

Gibraltar

Tangier

Morocco

MOROCCO

FEZ

ALGERIA (French)

Algiers

Oran

Tunis

SARDINIA

Palermo

Cagliari

Messina

Catania

Modica

Malta

Sousa

Sfax

Djerba

Gabes

TRIPOLI

Misrath

MEDITERRANEAN SEA

Smyrna

Zante

Candia

Canea

Sitia

Alexandria

CAIRO

Suez

Madeira

Funchal

CANARY IS

Teneriffe

Palmas

Gran Canaria

Lanzarote

Arrecife

TIRIS (Spanish)

SAHARA EL FALAT

(THE GREAT DESERT)

TRIPOLI (Turkish)

FEZZAN

EGYPT

LIBYAN DESERT

NUBIA

Sawakin

RED SEA

WADAY

DARFUR

St. Vincent

P. Grande

C. VERDE IS.

St. Jago

Fogo

Brava

St. Louis

SENEGAL (French)

C. Verde

Dakar

Bathurst

GAMBIA

Bissao

FRENCH SOUDAN

Los Is. (Fr.)

Freetown

SIERRA LEONE (Br.)

LIBERIA (Indep.)

Monrovia

ASHANTI

DAHOMEY

COMO

P. Novo

Lagos

NIGER TERRITORIES (British)

KAMERUN (German)

Prince's I. (Port.)

St. Thomas (Port.)

C. Lopez

Corisco B.

Libreville

Gaboon R.

KONGO FREE STATE (Belgian Protectorate)

GERMAN EAST

Kabinda (Port.)

Congo R.

Loanda

Benguela

Mossamedes

C. Frio

ANGOLA PORTUGUESE WEST AFRICA

BRITISH CENTRAL AFRICA

GERMAN SOUTH-WEST AFRICA

DAMARA LAND

WALFISCH B. (Brit.)

KALAHARI DESERT

BECHUANA LAND

S. AFRICAN REPUBLIC (TRANSVAAL)

ORANGE FREE STATE

NATAL

Durban

CAPE COLONY

P. Nolloth

Cape Town

C. of Good Hope

Algoa B.

Port Elizabeth

Alfred

Plettenberg Bay

Mossel Bay

Hermanus

P. Grande

Ceara

Natal

Parahiba

Pernambuco

Maceio

Aracaju

Bahia

Valenca

Camamu

Ilheos

Belmonte

P. Seguro

Caravellas

Victoria

S. Joao da Barra

RIO DE JANEIRO

Trinidade

St. Paul

Fo Noronha

Ascension I

St. Helena

Tristan da Cunha

S O U T H

A T L A N T I C

O C E A N

SOUTH GEORGIA

EMPIRE

PERSIA

AFGHANISTAN

KABUL

NEPAL

BHOTAN

BRITISH INDIA

ARABIAN SEA

BAY OF BENGAL

ANDAMAN IS

NICOBAR IS

LAKADIVE IS

MALDIVE IS

CEYLON

ARABIA

ABYSSINIA

BRITISH SOMALI

ITALIAN NORTHEAST AFRICA

BRITISH EAST AFRICA

EAST AFRICA

GERMAN EAST AFRICA

ZANZIBAR

SEYCHELLE IS

CHAGOS ARCH GO

Saya de Malha Bank

MADAGASCAR

Comoro

Diego Suarez

Mayotta

Nossi Bé

St. Mary I

Tamatave

ANTANANARIVO

Mauritius I

Port Louis

Malcheburg

Reunion

Mozambique

Durban (Natal)

Algoa Bay

Maputa Bay

Mozambique

Maskat

Bushire

Jask

Karachi

Bombay

Calcutta

Chittagong

Akyab

Berhampore

Chicacole

Vizagapatam

Cocanada

Masulipatam

Nellore

Madras

Pondicherry

Negapatam

Jafnapatam

Trincomali

Batticaloa

Colombo

Pt de Galle

Acheen Hd

Penang

Singapore

Malacca

Malay Penl

Gulf of Siam

Bangkok

Cochin China

China Sea

Java Sea

Java

Borneo

Sumatra

Sunda Str

Batavia

Padang

Bencoolen

Telok Betung

Sambawa

Bangawang

Timor

Sandal

Sarawak

Pinang

Rangoon

Martaban

Tavoy

Mergui

Junkseylon

Kampot

St James

Cape Liant

Cambodia

Saigon

Cambodia R

Tonquin

Hainan

Hong Kong

Canton

Amoy

Foochow

Shanghai

Ningpo

Chusan

Formosa

Loochoo

Japan

Yokohama

Nagasaki

Corea

Vladivostok

Krasnovodsk

Baku

Caspian Sea

Astrakhan

Rechi

Burfrouch

Tehran

Latakia

Beirut

Damascus

Yafa

Jerusalem

El Arish

Suez

Yambo

Medina

Jidda

Loheiya

Hodeida

Zubeir

Mocha

Aden

Sawakin

Kunfida

Beila

Lith

Makalla

Sheher

Muscat

Bunder Abbas

Gombroon

Bushire

Bahrein

Kurrachee

Sonmeeanee

Jask

Chahbar

Gwader

Ormara

Sonmeeanee

Bhawnagar

Surat

Goa

Vengurla

Kumpta

Mangalore

Cannanore

Calicut

Tellicherry

Mahe

Pondicherry

Vizagapatam

Chicacole

Ganjam

Balasore

Saugor I

False Pt

Akyab

Rangoon

Martaban

Tavoy

Mergui

Junkseylon

Diamond I

Elephant I

Archers

Sabroodee

Moulmein

Kampot

Cape Liant

St James

Cambodia

Saigon

Cambodia R

Tonquin

Hainan

Hong Kong

Canton

Amoy

Foochow

Shanghai

Ningpo

Chusan

Formosa

Loochoo

Japan

Yokohama

Nagasaki

Corea

Vladivostok

Krasnovodsk

Baku

Caspian Sea

Astrakhan

Rechi

Burfrouch

Tehran

Latakia

Beirut

Damascus

Yafa

Jerusalem

El Arish

Suez

Yambo

Medina

Jidda

Loheiya

Hodeida

Zubeir

Mocha

Aden

Sawakin

Kunfida

Beila

Lith

Makalla

Sheher

Muscat

Bunder Abbas

Gombroon

Bushire

Bahrein

Kurrachee

Sonmeeanee

Jask

Chahbar

Gwader

Ormara

Sonmeeanee

Bhawnagar

Surat

Goa

Vengurla

Kumpta

Mangalore

Cannanore

Calicut

Tellicherry

Mahe

Pondicherry

Vizagapatam

Chicacole

Ganjam

Balasore

Saugor I

False Pt

Akyab

Rangoon

Martaban

Tavoy

Mergui

Junkseylon

Diamond I

Elephant I

Archers

Sabroodee

Moulmein

Kampot

Cape Liant

St James

Cambodia

Saigon

Cambodia R

Tonquin

Hainan

Hong Kong

Canton

Amoy

Foochow

Shanghai

Ningpo

Chusan

Formosa

Loochoo

Japan

Yokohama

Nagasaki

Corea

Vladivostok

Krasnovodsk

Baku

Caspian Sea

Astrakhan

Rechi

Burfrouch

Tehran

Latakia

Beirut

Damascus

Yafa

Jerusalem

El Arish

Suez

Yambo

Medina

Jidda

Loheiya

Hodeida

Zubeir

Mocha

Aden

Sawakin

Kunfida

Beila

Lith

Makalla

Sheher

Muscat

Bunder Abbas

Gombroon

Bushire

Bahrein

Kurrachee

Sonmeeanee

Jask

Chahbar

Gwader

Ormara

Sonmeeanee

Bhawnagar

Surat

Goa

Vengurla

Kumpta

Mangalore

Cannanore

Calicut

Tellicherry

Mahe

Pondicherry

Vizagapatam

Chicacole

Ganjam

Balasore

Saugor I

False Pt

Akyab

Rangoon

Martaban

Tavoy

Mergui

Junkseylon

Diamond I

Elephant I

Archers

Sabroodee

Moulmein

Kampot

Cape Liant

St James

Cambodia

Saigon

Cambodia R

Tonquin

Hainan

Hong Kong

Canton

Amoy

Foochow

Shanghai

Ningpo

Chusan

Formosa

Loochoo

Japan

Yokohama

Nagasaki

Corea

Vladivostok

INDIAN OCEAN

St Paul

Crozet Is

Marion I

KERGUELEN I

Heard I

N.W Cape

Shark's

Port Gregory

Dongarra

40°

30°

20°

10°

0°

10°

20°

30°

40°

50°

JAVA SEA
Teluk Betung
SUNDA STR
JAVA
Banjuwangi
TIMOR
Kupang
CERAM
Amboina
Timor Laut
Dobbo
Arrula
ARAFURA SEA
PAPUA OR NEW GUINEA
Gulf of Papua
Thursday I.
C. York
TORRES STRAIT
NEW POMERANIA
Blanche B
Meoko Hbr
Treasury I.
SOLOMON IS
STA. CRUZ IS
Espirito Santo
NEW HEBRIDES
ELLICE IS
Funafuti
FIJI
NEW CALEDONIA
LOYALTY IS
Noumea
CORAL SEA
C. Melville
Cooktown
Cairns
Cardwell
Townsville
Bowen
Bloomsbury
Mackay
St. Lawrence
Mattaburra
Rockhampton
Gladstone
Sandy C
Maryborough
Gympie
Brisbane
Heads
Grafton
Kempsey
P. Macquarie
Newcastle
Sydney
Kiama
Moruya
Eden
Gabo I
Charleville
Alice Springs
GULF OF CARPENTARIA
Burketown
Moreton
P. Darwin
Palmerston
Yam Cr.
Derby
Broome
Roebourne
N.W. Cape
GEOGRAPHE CHAN
Sharks B
P. Gregory
Geraldton
Dongarra
Perth
Fremantle
Peel Inlet
Bunbury
Busselton
Pt. D'Entrecasteaux
Albany
King George Sd
Bremer B
Esperance B
Israelite B
Eyre
Eucla
Fowlers B
Streaky B
Elliston
Pt. Lincoln
C. Borda
Augusta
Wakefield
Adelaide
Wellington
Robe
Mc Donnell
Portland
Warrnambool
C. Otway
Melbourne
Sale
P. Albert
P. Wilson
AUSTRALIA
TASMANIA
Heads
Oyster B
Macquarie Hbr
Hobart
NORFOLK I
KERMA
NEW ZEALAND
Mongonui R
Russell
Whangerei
Hokianga
Warkworth
Auckland
Tokota
N. Plymouth
NORTH I
Wanganui
Wellington
Collingwood
Nelson
Westport
Charleston
Greymouth
Hokitika
Blenheim
Kaikoura
Christchurch
Akaroa Hbr
Ashburton
Timaru
Oamaru
Palmerston
Dunedin
Invercargill
Bluff Hbr
SOUTH
Macquarie I.
10°
20°
30°
40°
50°
60°
69°
100°
110°
120°
130°
140°
150°
160°
170°

PHOENIX IS
Enderbury I
Funafuti
UNION IS
Nukonono
SAMOAN IS
Apia
Pago Pago
FIJI IS
FRIENDLY IS
Tongatabu
HERVEY OR COOK IS
Rarotonga
Tubuai or Austral Is
SOCIETY IS
Tahiti
Fakarawa
TUAMOTU OR LOW ARCHIPELAGO
Taao Hiva
MARQUESAS IS
Easter I.
Raoul I
KERMADEC IS
Auckland
Tokota
Whakamarama
Napier
Gisborne
CHATHAM IS

S O U T H P A C I F I C

O C E A N

EXPLANATION.

The submarine cable connections that are marked with letters represent the telegraph cables that a and operated by sovereign states. Those that are marked with numbers represent telegraph cable owned and operated by private companies. The explanation of the names of the countries that represent and of the names of the companies that the numbers stand for is subjoined.

GOVERNMENTS.

A. Austria.
B. Belgium.
Br. Great Britain.
C. China.
C.C. Cochin China.
D. Denmark.
F. France.
G. Germany.
Gr. Greece.
I. Italy.
J. Japan.
M. Mexico.
N. Netherlands.
P. Portugal.
R. Russia.
S. Spain.
Sw. Sweden.
T. Turkey.
U.S. United States.

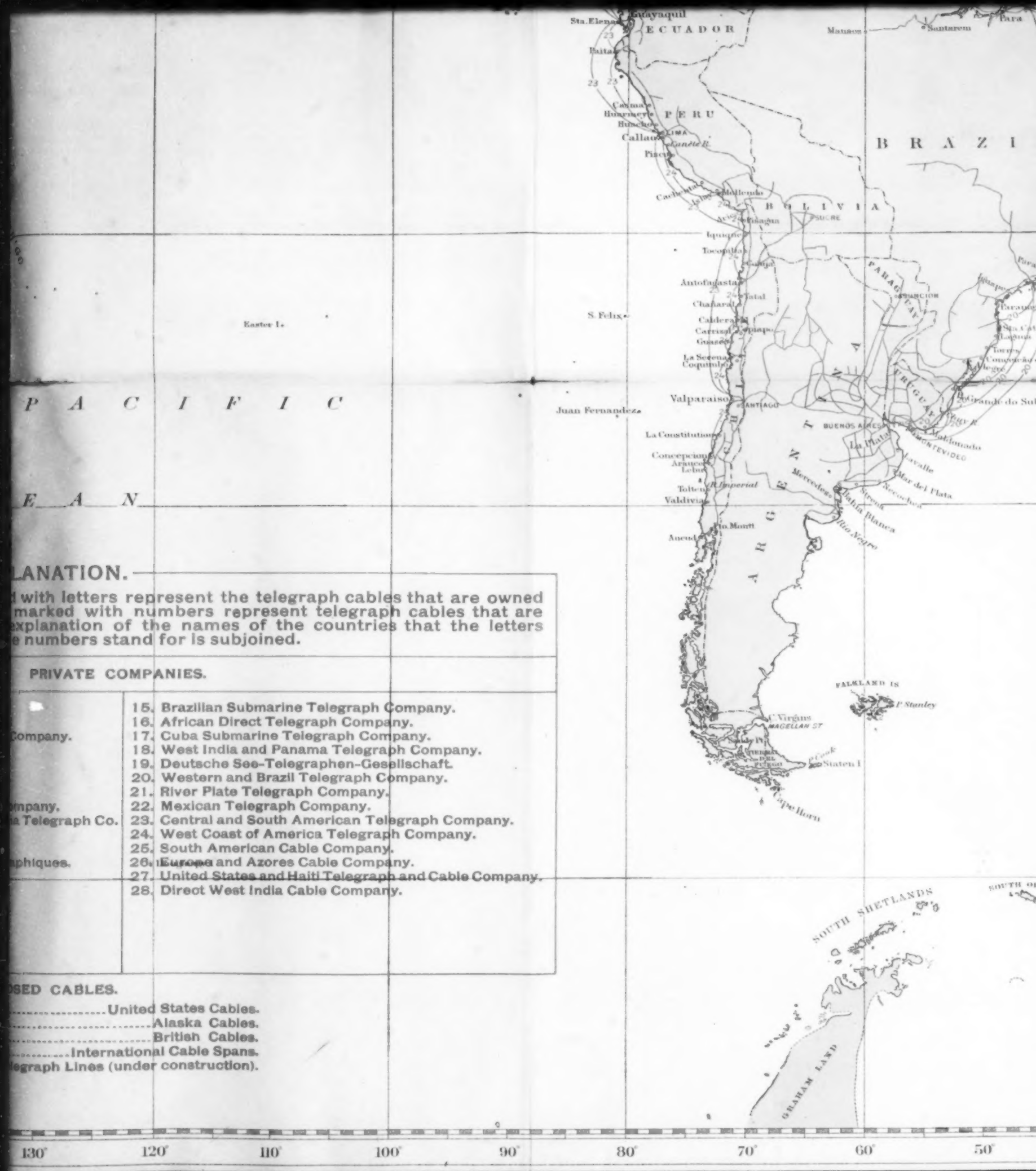
PRIVATE COMPANIES.

1. Direct Spanish Telegraph Company.
2. Halifax and Bermuda Cable Company.
3. Spanish National Submarine Telegraph Company.
4. West African Telegraph Company.
5. Black Sea Telegraph Company.
6. Great Northern Telegraph Company.
7. Eastern Telegraph Company.
8. Eastern and South African Telegraph Company.
9. Eastern Extension, Australasia, and China Telegraph Co.
10. Anglo-American Telegraph Company.
11. Direct United States Cable Company.
12. Compagnie Française des Câbles Télégraphiques.
13. Western Union Telegraph Company.
14. The Commercial Cable Company.
15. Brazilian Submarine Telegraph Company
16. African Direct Telegraph Company.
17. Cuba Submarine Telegraph Company.
18. West India and Panama Telegraph Comp
19. Deutsche See-Telegraphen-Gesellschaft
20. Western and Brazil Telegraph Company.
21. River Plate Telegraph Company.
22. Mexican Telegraph Company.
23. Central and South American Telegraph C
24. West Coast of America Telegraph Compa
25. South American Cable Company.
26. [illegible] and Azores Cable Company.
27. United States and Haiti Telegraph and Ca
28. Direct West India Cable Company.

PROPOSED CABLES.

— — — — — ..... United States Cables.
+++++++++ ..... Alaska Cables.
·—·—·—·— ..... British Cables.
+–+–+–+–+ ..... International Cable Spans.
oooooooooooooo ... Alaska Telegraph Lines (under construction).

180° 170° 160° 150° 140° 130° 120° 110° 100°



LANATION.

l with letters represent the telegraph cables that are owned
marked with numbers represent telegraph cables that are
xplanation of the names of the countries that the letters
e numbers stand for is subjoined.

PRIVATE COMPANIES.

Company.
mpany.
a Telegraph Co.
phiques.

15. Brazilian Submarine Telegraph Company.
16. African Direct Telegraph Company.
17. Cuba Submarine Telegraph Company.
18. West India and Panama Telegraph Company.
19. Deutsche See-Telegraphen-Gesellschaft.
20. Western and Brazil Telegraph Company.
21. River Plate Telegraph Company.
22. Mexican Telegraph Company.
23. Central and South American Telegraph Company.
24. West Coast of America Telegraph Company.
25. South American Cable Company.
26. Europe and Azores Cable Company.
27. United States and Haiti Telegraph and Cable Company.
28. Direct West India Cable Company.

OSED CABLES.

.....United States Cables.
.....Alaska Cables.
.....British Cables.
.....International Cable Spans.
legraph Lines (under construction).

Para
Fo Noronha
Natal
Parahiba
Pernambuco
Maceio
Aracaju
Bahia
Valença
Camamu
Ilheos
Belmonte
P. Seguro
Caravellas
Victoria
Trinidade
Rio de Janeiro
Santos
Paranagua
Sa Catherina I
Laguna
Torres
Conceição do Arroio
Rio Grande do Sul
Ascension I
St. Helena
Tristan da Cunha
SOUTH GEORGIA
SANDWICH GROUP
SOUTH ORKNEYS
Bouvet I
KONGO FREE STATE (Belgian Protectorate)
Kabinda (Port.)
Kongo R.
Loanda
Benguela
Mossamedes
C. Frio
ANGOLA PORTUGUESE WEST AFRICA
GERMAN SOUTH-WEST AFRICA
DAMARA LAND
Walfisch B.
KALAHARI DESERT
BRITISH BECHUANA LAND
BRITISH SOUTH AFRICA
GERMAN EAST AFRICA
BRITISH CENTRAL AFRICA
EAST AFRICA
MOZAMBIQUE
MATABELE LAND
MASHONA LAND
S. AFRICAN REPUBLIC (TRANSVAAL)
ORANGE FREE STATE
NATAL
CAPE COLONY
Angra Pequena
Delagoa Bay
Durban (Port Natal)
P. Nolloth
Cape Town
C. of Good Hope
Mossel Bay
E. London
Port Elizabeth
Algoa B.
Algoa Bay
Bamaunsdorp
Bagamoyo
Dar-es-Salaam
Mikindani
SOUTH ATLANTIC OCEAN
Marion I.
40° 30° 20° West Longitude 10° Meridian of 0° Greenwich 10° East Longitude 20° 30°

St Paul

Fernando Noronha

Natal

Parahiba

Pernambuco

Maceio

Aracaju

Ascension I

St Helena

Trinidad

Victoria

S. Joam da Barra

DE JANEIRO

S O U T H

A T L A N T I C

O C E A N

Tristan da Cunha

SOUTH GEORGIA

SANDWICH GROUP

Bouvet I

KAMERUN (German)

Corisco B.

Princes I.

St Thomas

C. Lopez

KONGO FREE STATE (Belgian Protectorate)

Kabinda

Kongo R.

Loanda

Benguela

Mossamedes

C. Frio

ANGOLA PORTUGUESE WEST AFRICA

BRITISH CENTRAL AFRICA

GERMAN EAST AFRICA

Bagamoyo

Dar-es-Salaam

BRITISH EAST AFRICA

Mikindani

MOZAMBIQUE

GERMAN DAMARA LAND SOUTH-WEST AFRICA

Walfisch B.

KALAHARI DESERT

BRITISH BECHUANA LAND

S. AFRICAN REPUBLIC (TRANSVAAL)

ORANGE FREE STATE

NATAL

Delagoa Bay

Durban

P. Nolloth

CAPE COLONY

Cape Town

C. of Good Hope

Simons B.

Hermanus

E. London

Port Alfred

Port Elizabeth

Algoa B.

Mossel Bay

Marion I.

40° 30° 20° West Longitude 10° Meridian of 0° Greenwich 10° East Longitude 20° 30° 40

ITISH
EAST
FRICA
Lamu
Melinda
Mombasa
ZANZIBAR
Salaam
FRICA
Mikindani
ST AFRICA
MOZAMBIQUE
Bay
SEYCHELLE IS
Mahe
MALDIVE IS
CHAGOS ARCHGO
Diego Garcia
Saya de Molhs Bank
Comoro
Mayotta
Diego Suarez
Nossi Bé
Mozambique
MADAGASCAR
St. Mary I.
Tamatave
ANTANANARIVO
Mauritius I.
Louis
Mahebourg
Reunion
St Paul
Crozet Is
KERGUELEN I.
Heard I
INDIAN OCEAN
Acheen Hd
SIAM
MALAY PENINSULA
Penang
Medaka
Singkel R.
Tapanooly
Pulo Nias
Labuan
Sadong
Sarawak
BORNEO
Pontianak
Jambi
Padang
Bengkulen
Banjermassin
Telok Betong
SUNDA STR.
JAVA SEA
Samarang
JAVA
Sourabaya
Bangawangi
N.W. Cape
GEOGRAPHE CHAN.
Sharks B.
Flinders
Dongarra
0°
10°
20°
30°
40°
50°
60°
69°
40°
50°
60°
70°
80°
90°
100°
110°

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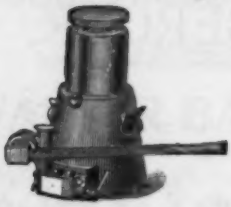
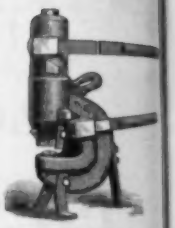
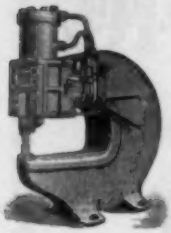


Horizontal
Outside Pump
Hydraulic Jack.
Sheet 20.





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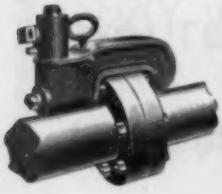

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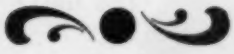

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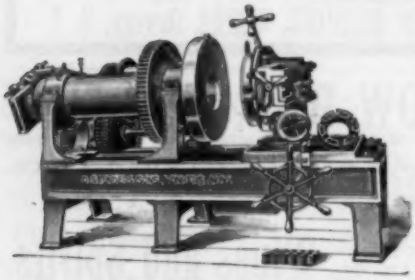

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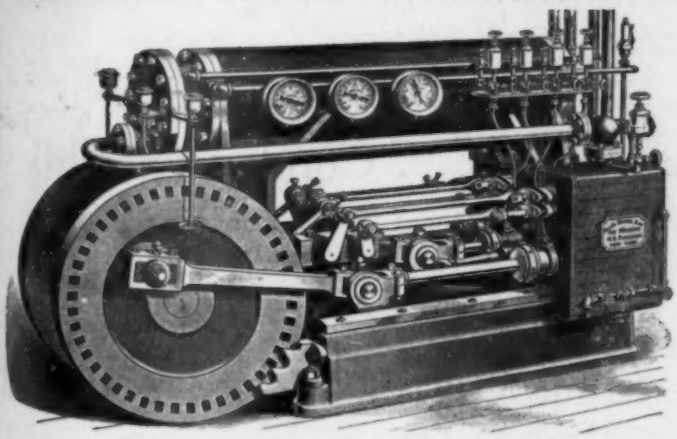

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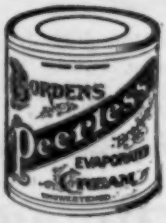

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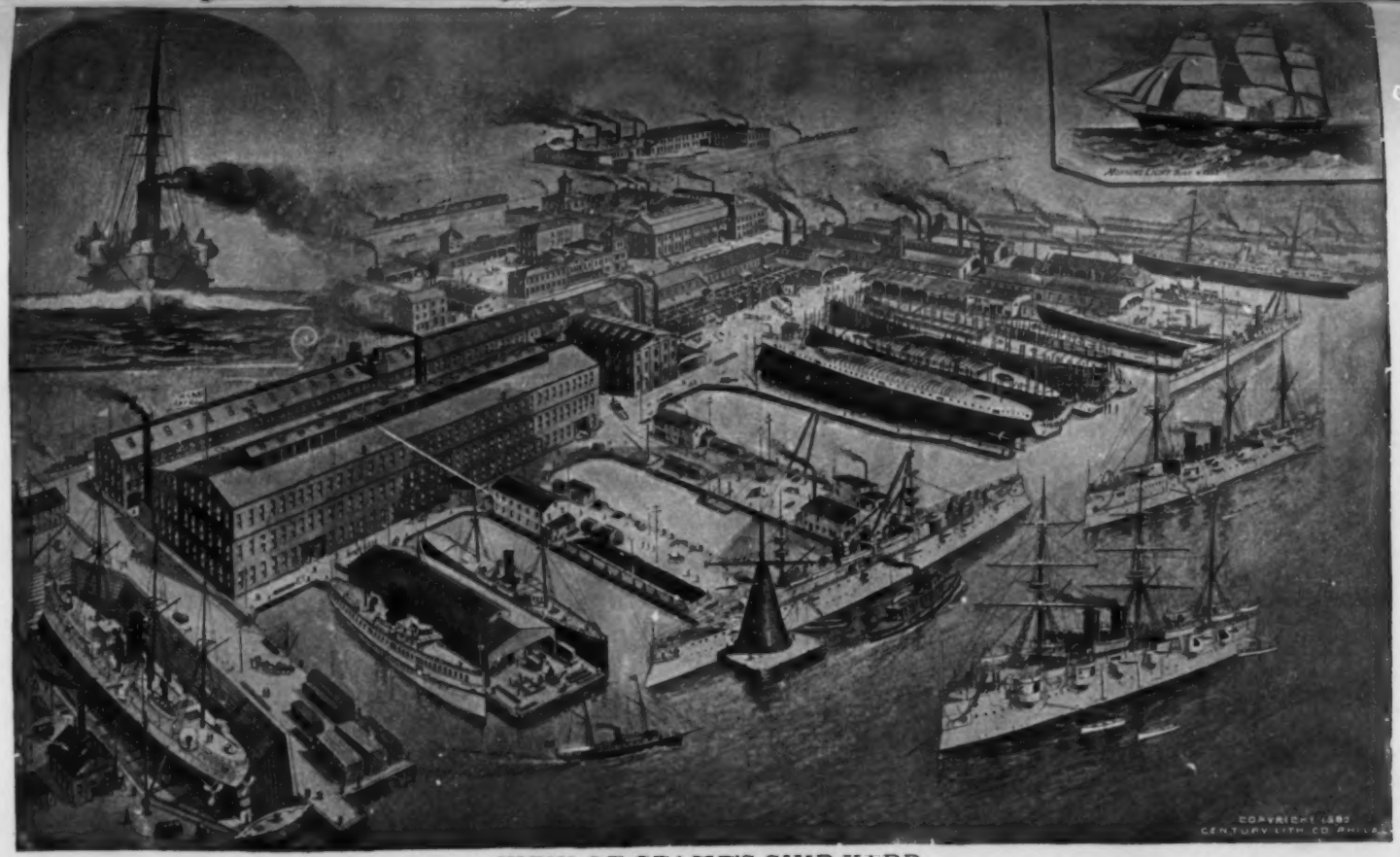

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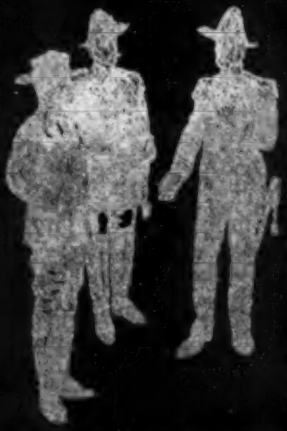

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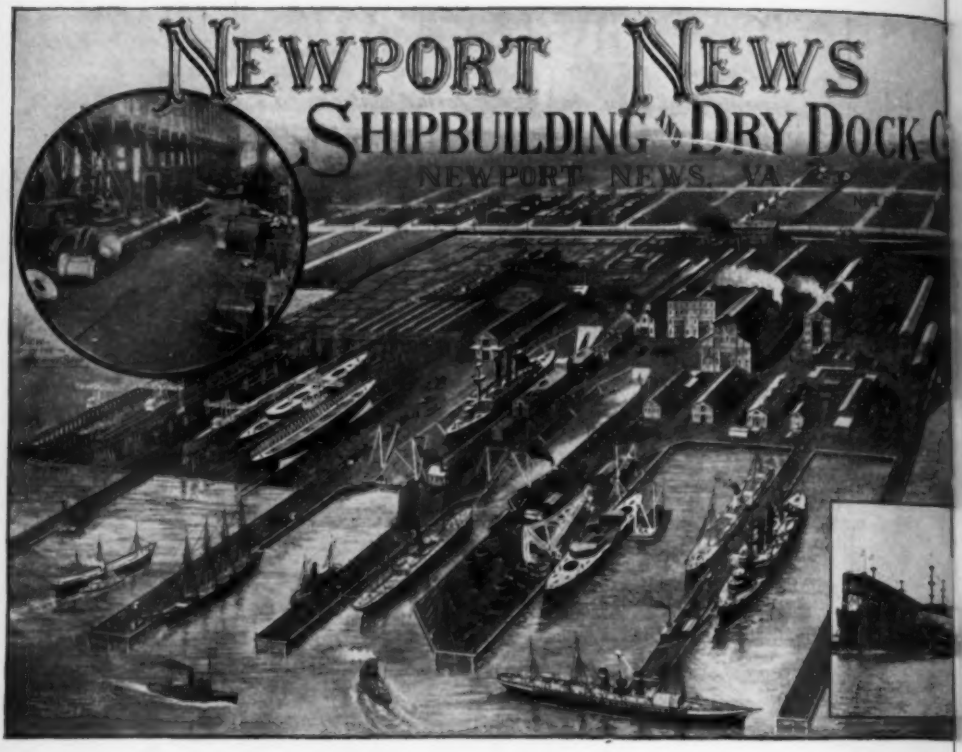

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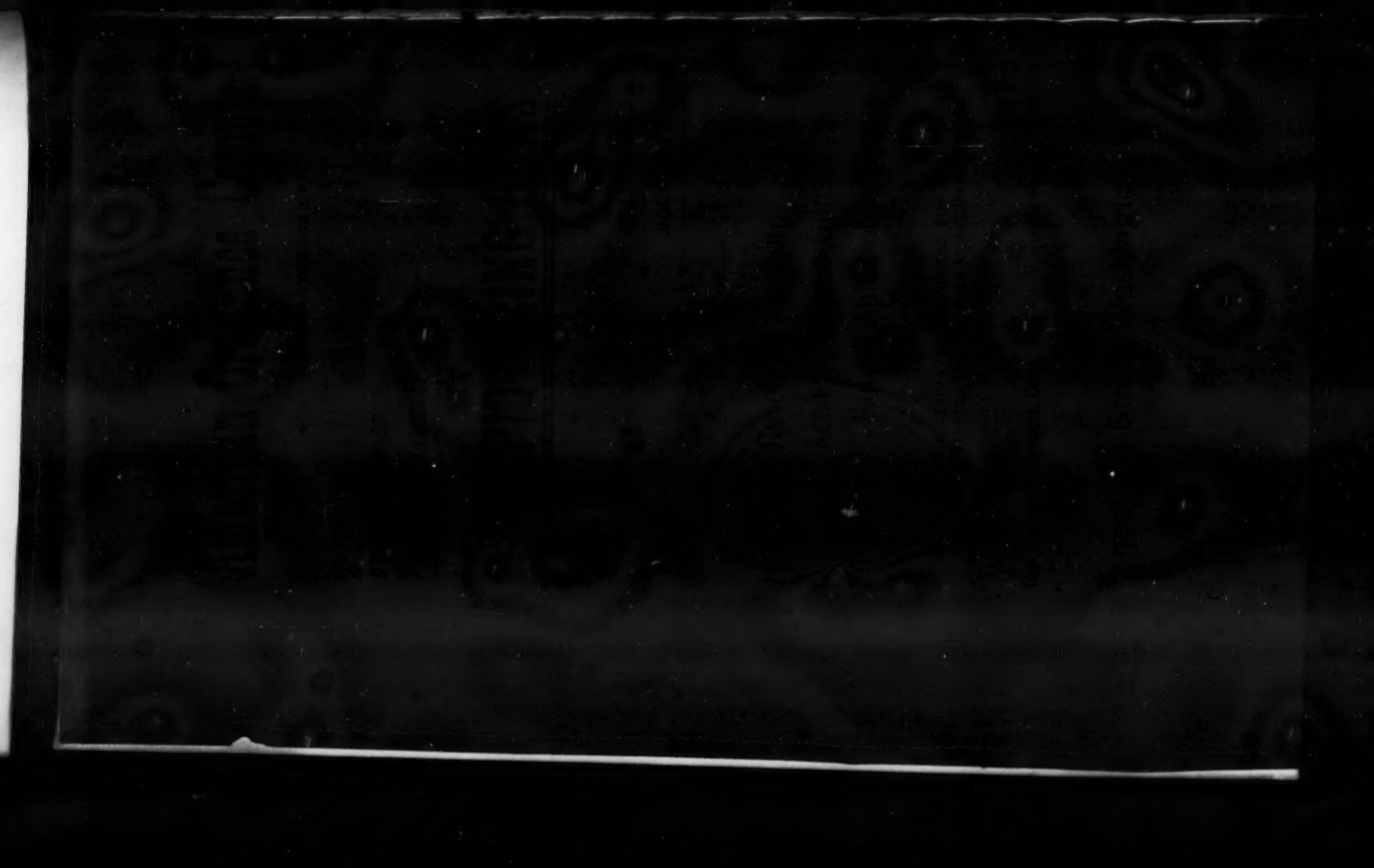
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